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JULY 2025

AIR POWER INTO THE FUTURE

IATA SUMMIT

SUSTAINABILITY ON THE AGENDA

BEYOND THE ISS

AS NASA STEPS BACK, CAN PRIVATE ENTERPRISE STEP UP?

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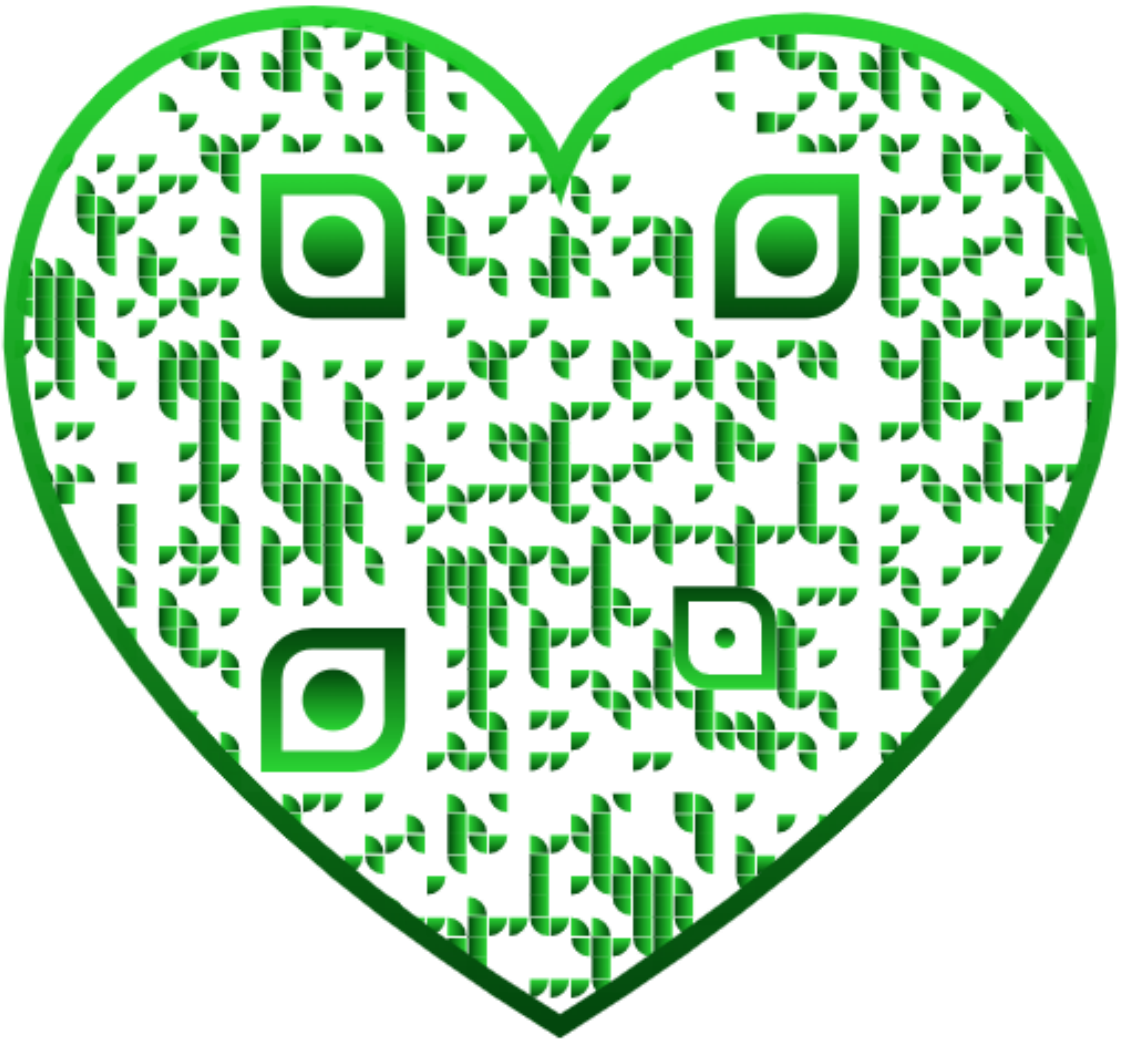

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AEROSPACE

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EDITORIAL

Revolution postponed

Since the invasion of Ukraine, a vast amount of ink (digital and otherwise) has been spilled on whether the widespread use of drones in the conflict represents a fundamental turning point in the history of air warfare. It was argued that swarms of thousands of low-cost drones will dominate future skies and consign the piloted fighter to the same dustbin of history as the chariot, crossbow and battleship – a technology whose time has been and gone.

Yet the stunning overmatch of Israel's air campaign against Iran in mid-June was noteworthy in that it was piloted combat aircraft that were once again the tip of the spear. Aided by multiple stand-off weapons, tankers, ISR aircraft and SF teams on the ground (using smaller drones to take down particularly stubborn air defences), such was the success of this effort by the Israeli Air Force (IAF) that large UAVs were reportedly able to operate over Tehran in daylight unmolested in just days – an achievement that perhaps arguably outstrips Operation Desert Storm in its speed and efficiency in securing the skies.

Furthermore, this was conducted against an enemy that, some argued, was embracing the future (perhaps more out of necessity than choice) by investing in thousands of ballistic missiles, cheap drone swarms and cyber capabilities to give it an asymmetric edge. Yet apart from the occasional missile or drone that managed to penetrate Israel's missile defences, it has been (at the time of writing) remarkably one-sided. Cheap and plentiful combat mass in this sense made no difference against the IAF's stealth fighters.

Longer term, the shift to more autonomous weapon systems is inevitable but, as the IAF (and the USAF B-2 strike on Iran's nuclear enrichment facilities – possibly the most heavily buried target in the world) show, crewed combat aircraft still provide decision-makers with the ultimate tool to project air power, shaping and affecting geopolitics for decades to come.

Tim Robinson FRAeS, Editor-in-Chief
tim.robinson@aerosociety.com @RAeSTimR

Correspondence on all aerospace matters is welcome at: **publications@aerosociety.com**

Editor-in-Chief
Tim Robinson FRAeS
+44 (0)20 7670 4353
tim.robinson@aerosociety.com

Deputy Editor
Stephen Bridgewater FRAeS
+44 (0)20 7670 4351
stephen.bridgewater@aerosociety.com

Features Editor
Jack Richardson
+44 (0)20 7670 4352
jack.richardson@aerosociety.com

Production Manager
Wayne J Davis FRAeS
+44 (0)20 7670 4354
wayne.davis@aerosociety.com

Production Executive
Annabel Hallam
+44 (0)20 7670 4361
annabel.hallam@aerosociety.com

Book Review Editor
Tony Pilmer FRAeS
book.reviews@aerosociety.com

Editorial Office
Royal Aeronautical Society
No.4 Hamilton Place
London W1J 7BQ, UK
+44 (0)20 7670 4300
publications@aerosociety.com
www.aerosociety.com

Chief Executive
David Edwards FRAeS

Advertising
+44 (0)20 7670 4346
partners@aerosociety.com

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To place your order, contact:
Wayne J Davis
+44 (0)20 7670 4354
aerosubs@aerosociety.com

Any member not requiring a print version of this magazine should contact: membership@aerosociety.com

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Front cover: Beyond the ISS: NASA's bold shift to commercial space stations. (Voyager Space)

AEROSPACE INSIGHT

Additional content is available to view online at: aerosociety.com/aerospaceinsight
Including: Traffic! Traffic! The past, present and future of collision avoidance, Integral to a new era, Warfighting Ready? Commentary on the 2025 *Strategic Defence Review*, Global air chiefs set to gather in UK, plus our daily coverage from the 2025 Paris Air Show.

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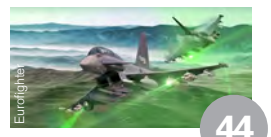

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ABBIES 2024 Award Winner

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Blueprint

Lanying R6000

Length	38ft
Width	57ft
Max cruise speed	296kt
Max take-off weight	13,450lb
Max payload	4,400lb
Range	2,160nm
Mission radius	810nm
Service ceiling	25,000ft
Hovering celing (OGE)	6,500ft

Turboshafts

Power comes from two Aero Engine Corporation of China (AECC) AES100 turboshaft engines. The 1,340shp-class engine was recently awarded its type certificate in June.

Passenger or cargo

The R6000 can be configured as a passenger or cargo version with a rapid conversion modular design – and fitted with six seats for VIP transport or 12 in a high-density VTOL regional air mobility configuration. In the air ambulance/ HEMS role it could carry two to four patients and four paramedics.

United Aircraft

AEROSPACE

Chinese tiltrotor gets set to fly

After carrying out a successful ground run of its propulsion system in June, China's United Aircraft is set to perform its first hovering flight of its R6000 tiltrotor this month. The 6t aircraft, which was only revealed in September 2024, is aimed at the civil market, including high-speed, long-range VTOL regional mobility for 6-12 passengers, medevac, cargo and government missions. Said Dr Tian Gangyin, CEO of United Aircraft: "As an aviation-grade unmanned platform, the R6000 represents a breakthrough in tiltrotor technology. Its innovative design empowers long-range, point-to-point mobility, and we are committed to reshaping future transportation and urban structure through this platform." The aircraft is also designed to be operated fully autonomously if required. Certification is expected to be completed by 2027.

Tilting rotors

Like the Bell V-280 Valor, the R6000 only tilts the rotor itself, rather than the entire nacelle. That keeps the engine exhaust pointed rearwards, assisting in passenger and crew disembarking, cargo handling and reducing thermal downwash on helipads and maritime platforms.

Autonomous options

The R6000 is designed to be operated in both piloted and fully autonomous versions.

Flight path to transition

After ground engine runs, remotely flown hovering tests are set to begin, followed by full tiltrotor flight and transition to forward flight.

United Aircraft

Radome

FIRST NEWS FROM THE PARIS AIR SHOW

AEROSPACE

Defence takes centre stage in a subdued Paris

With the show taking place only days after the fatal crash of an Air India Boeing 787 Dreamliner with the loss of at least 260 people, senior Boeing executives stayed away from the show as a mark of respect with commercial sales announcements and media activity from the US airframer also curtailed. In addition, there was controversy on the first day when the exhibition organisers, seemingly under pressure from the French government itself, erected a black curtain around Israeli company stands at the show (including Elbit Systems, Rafael, IAI and UVision) that had lethal weapon systems on display in the wake of an escalating Israel-Iran war and the ongoing conflict in Gaza.

DEFENCE

C-390 continues sales momentum

Tim Robinson/RAeS

The standout sales winner on the defence side was Embraer's C-390 Millennium tactical airlifter/tanker which, as well as Brazil, has also won orders from Portugal, Hungary, the Netherlands, Austria, Czech Republic, Sweden, Slovakia and South Korea. At the show, Portugal announced it would be buying a sixth airframe, as well as ordering 10 'whitetails' that could be placed with NATO or other allies – government-to-government sales being a faster procurement method. Finally, on 18 June, Embraer announced that Lithuania had selected the C-390 and would be acquiring three airframes.

AIR TRANSPORT

Airline orders highlights

Airbus

While the total orders, LoIs, MoUs and commitments reached 601 by the end of the show trade days, firm numbers were lower with Airbus recording 148 firm orders, worth $14.2bn and provisional orders for 102 worth $6.7bn. Highlights for Airbus included LOT Polish Airlines purchasing A220s and A350-1000 orders from Riyadh Air and STARLUX Airlines and a Vietjet Air MoU for 100 A321neos. While Boeing chose not to announce any sales, Embraer also secured deals for 79 E-Jets, including two E-freighters for Regional One, along with ATR (15 orders and 10 options) and De Havilland Canada (5 aircraft).

AEROSPACE

Watch the PAS25 wrap-up video report

Catch-up with the news highlights from the Paris Air Show with this video summary from the *AEROSPACE* team by clicking on this QR code.

FULL REPORT IN NEXT ISSUE

NEWS IN BRIEF

US start-up, JetZero has announced that it has concluded the critical design review (CDR) for its Z4 Blended Wing Body aircraft, with the next milestone being to build an 'iron bird' test rig. The company plans to certify the aircraft under the FAA's Part 25 rules. A full-scale demonstrator is set to fly in mid-2027.

The Vietnamese government has granted a licence to Sun PhuQuoc Airways, joining Sun Group's Sun Air business jet subsidiary. Plans are for the new airline to connect Phú Quoc island with the rest of Vietnam, followed by destinations in Russia, Europe, Australia, Central Asia and the Middle East. Operations are planned to start later this year with A321neos.

Pro-Palestinian activists damaged two RAF Voyager tankers during a break-in at RAF Brize Norton, causing £55m worth of damage by spraying them with paint, having entered the base on electric scooters. As a result, the 'Palestinian Action' group has been proscribed as a terrorist group by the Home Office and a review into the security of the UK defence estate has been launched.

According to the Aerospace Information Research Institute (AIR) of the Chinese Academy of Sciences, the nation has made a breakthrough in building a high-speed 'data highway' between satellites and the ground. It claims to have tested a high-throughput satellite-to-ground data transmission system that achieved an X-band single-channel data rate of 2,100Mbps using 128QAM modulation. It refers to this as a 75% increase over satcom speeds.

UK eVTOL developer, Vertical Aerospace is to establish a 'ready to fly' eVTOL model with offshore operator, Bristow Group. Under this arrangement, a fully integrated solution will be offered with access to a certified aircraft, personnel and insurance. Bristow has also placed a pre-order for 50 VX4s with an option for a further 50.

Beijing-based space start-up, Sepoch,

AIR TRANSPORT

Air India 787 crashes on take-off

A Boeing 787 Dreamliner, operated by Air India, crashed shortly after take-off from Ahmedabad International Airport in Western India on 12 June, killing at least 260 people, including 18 on the ground. The aircraft was bound for London Gatwick Airport and carried 242 passengers, with 169 from India, 53 from the UK, seven from Portugal and one Canadian – with one survivor, a British national sitting in seat 11A, miraculously escaping the crash. The airline has ordered precautionary checks to its 787 fleet. An accident investigation is now under way.

AEROSPACE

SAF-ready D328eco prototype rolled out

Deutsche Aircraft rolled out the test prototype of the D328eco on 28 May at its HQ in Oberpfaffenhofen, Germany. Based on the Dornier 328 regional airliner, the new aircraft has 25% increased passenger capacity and greater range. The D328eco is 6ft 7in longer than the original aircraft and can carry 40 passengers, while power comes from a pair of Pratt & Whitney Canada PW127XT-S turboprops that are claimed to be 14% more efficient than their predecessors and also help the aircraft operate from 1,028m runways. The aircraft is also planned to be 100% SAF compatible when it enters service. The flight deck has been optimised with single-pilot operations in mind and the aircraft will be approved for steep approaches of up to 5.5°.

SPACEFLIGHT

SpaceX Starship 36 explodes on the pad in Texas

On 18 June, a SpaceX Starship exploded on the launch pad in Texas during static fire tests ahead of the tenth orbital flight. The company said that the rocket "experienced a major anomaly while on a test stand at Starbase" with video showing that Starship 36 had been completely destroyed in the explosion. The launch pad failure is the latest in a series of setbacks for Starship, which saw the ninth flight on 27 May also end in disaster when the upper stage suffered a loss of attitude control and burnt up on re-entry. Meanwhile, SpaceX's future hung in the balance in early June as US President, Donald Trump and SpaceX founder, Elon Musk conducted a bitter public spat on social media – with Trump threatening to cancel all SpaceX's government contracts and Musk saying he would retire the Dragon capsule early.

IRAN STRIKES

DEFENCE

US strikes Iranian nuclear sites

On 21 June and following Israel's 'Rising Lion' air campaign (see 'News Insight' p11) against Iranian air defences, ballistic missile launchers and military targets, the US launched Operation Midnight Hammer – a B-2 and cruise missile strike targeting Iran's nuclear weapons enrichment and processing facilities in three sites at Fordo, Natanz and Isfahan. The strike saw almost the entire USAF B-2 force used in the operation, with seven aircraft flying direct from the continental US while a decoy force threatened to strike from Guam. Over 125 aircraft, including tankers, fourth/fifth-generation fighters as escorts and submarine-launched Tomahawk missiles were in involved in the operation. The raid also saw the first combat use of the GBU-57 (Massive Ordnance Penetrator) bombs designed to defeat deeply buried targets, such as Fordo. Battle damage assessment is as yet unconfirmed but initial reports suggest that the facilities were damaged and development of Iranian nuclear weapons set back.

completed its first 'rocket delivery' on 29 May when its reusable XZY-1 rocket transported 20kg of packages from Alibaba's Taobao, one of the country's largest e-commerce platforms, during a test flight. The 88ft tall stainless steel rocket, weighing 57t and powered by liquid oxygen and methane, flew for 125 seconds and reached an altitude of 8,000ft before successfully landing vertically on the sea surface near Shandong province. The XZY-1's cargo bay is designed to carry up to 10t of cargo, including small trucks.

Troubled American carrier, Silver Airways has officially ceased trading, having filed for bankruptcy in December. The Florida-based airline made its final flight from Tampa to Fort Lauderdale International on 10 June. No bids were made for the airline, resulting in an auction being cancelled.

Anduril Industries has formed a partnership with Rheinmetall for the latter to produce autonomous and advanced propulsion systems for the European market. Examples include local variants of the Barracuda missile, Fury CCA combat drone and solid rocket motor production.

United Launch Alliance has deployed the next batch of 27 Amazon Kuiper broadband mega-constellation satellites on board its Atlas V rocket. The satellites, which launched from Cape Canaveral on 21 June, join 27 already launched in April. Amazon plans for the constellation to eventually comprise 3,236 satellites.

Gulfstream Aerospace has announced that its G700 business jet has passed two key milestones. One is a record speed flight from Teterboro, New Jersey to San Francisco in 9 hours 26 minutes while the other, flying to the Paris Air Show on sustainable aviation fuel, resulted in sustainable wings accreditation from the National Aeronautic Association.

Researchers at Massachusetts Institute of Technology (MIT) have published work that suggests new

Radome

DEFENCE

Gripen E flies with AI BVR co-pilot

On 28 May, Saab, in conjunction with AI start-up Helsing, carried out a successful trial of an AI agent in a beyond-visual-range (BVR) air-to-air combat scenario using a Gripen E fighter. The test utilised Helsing's Centaur AI system on an operational (instead of test) Gripen E fighter aircraft where the pilot received information and advice on how to execute a dogfight scenario with prompts, such as the optimum time to fire a generic missile type. Funded by Sweden's FMV, it was made possible by the Gripen E's partitioned software system that separates critical flight controls from mission systems.

AIR TRANSPORT

UK CAA releases airport accessibility ratings

The UK's Civil Aviation Authority has released its annual report into accessibility at the nation's airports covering the April 2024 to March 2025 period. According to the report, 5.5m passengers asked for assistance at UK airports during that time, representing 1.9% of the total number. Overall, it found that 11 airports received a 'very good' rating, including Newcastle, Exeter and London Gatwick, the latter of which 'needed improvement' last year. Most of the airports achieved a 'good' ranking, including Bristol, Birmingham and Glasgow while three, London Heathrow, Edinburgh and Glasgow Prestwick 'require improvement.' The latter was criticised for failing to engage with disabled groups. No airport was rated as poor.

SPACEFLIGHT

Fourth private astronaut mission launches to ISS

On 25 June, the Axiom-4 private space mission successfully launched to the International Space Station atop a SpaceX Falcon 9 for a two-week stay. The Crew Dragon pilot, Group Captain Shubhanshu Shukla is the first Indian national to go into space for 41 years, with the mission commanded by former NASA astronaut, Peggy Whitson, who has carried out ten space walks and commanded the ISS twice. Alongside her and the pilot are Sławosz Uznanski-Wisniewski from Poland and Tibor Kapu from Hungary, both of whom are their countries' first astronauts for more than 40 years. This is the fourth private mission to the ISS, carried out as a collaboration between Houston-based Axiom Space, NASA, ESA and India's ISRO space agency.

AEROSPACE

Quarterhorse Mk 1 takes to the skies

US hypersonic developer Hermeus successfully flew its Quarterhorse Mk 1 demonstrator for the first time in late May. The uncrewed GE J85-powered aircraft flew from Edwards AFB in California and in a post on X, Hermeus founder, Skyler Shuford claimed that it had taken just 19 months to get from the drawing board to its first flight – something he claimed was a world record for a jet aircraft. The next model, called Quarterhorse Mk 2, which is capable of reaching high supersonic speeds, is also expected to fly before the end of 2025.

NEWS IN BRIEF

liquid sodium fuel cell technology could triple the energy density of batteries used in electric aircraft. The team claims the new fuel cell-based concept could more than triple lithium-ion's current energy density from 300 Watt hours per kilogram (Wh/kg) to 1,000Wh/kg.

Taiwanese carrier, UNI Air has ordered 19 ATR 72-600 turboprop regional airliners. Planned mainly for use in the domestic market and intended for delivery between 2027 and 2032, this is the second order UNI has made for ATRs following the purchase of ten in 2011.

Edgewing has been revealed as the name of the tri-national industrial joint venture comprising BAE Systems, Leonardo and Japan Aircraft Industrial Enhancement to deliver the Global Combat Air Programme (GCAP).

The US Space Force has postponed the launch of its first next-generation overhead persistent infrared spacecraft. The first of the two devices will now launch next year, with the USSF citing high demand for launch services.

On 3 June, Joby Aviation announced it had signed an MoU with Abdul Latif Jameel, a diversified business conglomerate based in Saudi Arabia, for 200 of its eVTOL aircraft. The deal, worth $1bn, also sets a framework for the two companies to co-operate in the development of AAM business opportunities in Saudi Arabia.

Rolls-Royce has launched a durability enhancement package for the Trent 1000 engine. The first of two such packages, it is aimed at increasing the amount of time between regular maintenance overhauls.

KLM and Transavia have teamed up with Dutch electric aircraft manufacturer Elysian to bring the latter's E9X aircraft to market. The three companies will hold a series of joint workshops to boost rollout speed in the technical and commercial areas.

Italy has phased out almost all of its legacy MB-339A jet trainers after 45 years service. During the changeover ceremony at Lecce-Galatina Air Base on 12 June, the replacement Leonardo

DEFENCE

RAF to acquire F-35As with US B-61 nuclear bombs

The RAF is to regain its airborne nuclear deterrent through the purchase of at least 12 F-35As to be equipped with US owned B-61 bombs - joining other NATO nations in the dual capable mission. Prime Minister, Sir Keir Starmer made the announcement at the NATO summit in The Hague where leaders gathered against the backdrop of conflict in Ukraine and the Middle East at a time when President Trump is pressuring European nations to spend more on defence. The aircraft will be based at RAF Marham in Norfolk with the government "expected to procure 138 F-35s over the lifetime of the programme". They will also have a training role with 207Sqn. The UK has lacked an airborne nuclear weapon since 1998.

GENERAL AVIATION

Gamebirds join Emirates for UPRT

Emirates

Dubai's Emirates Flight Training Academy has added a pair of Gamebird GB1 aerobatic aircraft to its fleet. Cadet airline pilots will now complete five hours of upset prevention and recovery training (UPRT) on the aircraft in addition to their existing training on the EFTA fleet of Cirrus, Embraer Phenom and Diamond aircraft.

AIR TRANSPORT

Aeroflot CEO calls for quotas of Russian-made airliners

UAC

Speaking to Russian newspaper, *Kommersant* on 5 June, Aeroflot CEO, Sergey Alexandrovsky called for limitations to be imposed on the use of Western-made aircraft by Russian airlines and suggested that a quota of domestically produced aircraft should be forced upon all Russian carriers. Alexandrovsky claims larger production runs would guarantee better manufacturing quality and aid more rapid development of new types.

AEROSPACE

US to repeal 52-year old overland supersonic flight ban

US President, Donald Trump signed an Executive Order on 6 June to repeal the ban restricting supersonic flights over the US. The ban came into place in 1973 with noise pollution and sonic booms cited as the concern. The advent of new technologies – such as Boom Supersonic's 'boomless cruise' – combined with some US companies developing civil supersonic has led to the 52-year-old restriction being lifted.

- Meanwhile, on the same day, another Executive Order from the White House, entitled 'Unleashing American Drone Dominance' was issued. This aims to prioritise and accelerate the rollout of Advanced Aerial Mobility (AAM), including eVTOLs and UAVs.

T-345A was formally inducted into service.

BAE Systems is to co-operate with Hanwha to develop an advanced sensor satellite system. The MoU will combine BAE's ultra-wide band RF sensors with Hanwha's advanced SAR to produce a solution for the international market.

According to national media, Russia's S7 Technics (a subsidiary of S7 Airlines) will shortly start testing the new APD-520 Leader aircraft engine. The 200hp six-cylinder engine is being developed to power the four-seat Tango light aircraft produced by Spectra Aircraft Design Bureau, which is also part of the S7 Group.

US Department of Transportation Secretary, Sean Duffy has launched a search for innovators who can overhaul the nation's air traffic control system. The FAA hosted a three-day 'Industry Days' workshop in June with FAA Acting Administrator, Chris Rocheleau saying: "This is a once-in-a-generation opportunity for a new, world-class air traffic system. We need world-class innovators to step up and tell us the best way to build it."

Indian low-cost carrier, IndiGo has placed a firm order for 30 Airbus A350-900, doubling its commitment to 60 aircraft. The latest 30 were options included in the original 2023 purchase deal. Speaking at the IATA AGM in Delhi on 2 June, the airline's CEO, Pieter Elbers, described the purchase as a "strategic step" that formed part of IndiGo's expansion into the long-haul market. .

European defence start-up, Helsing has acquired light aircraft and training systems manufacturer, Grob Aircraft. Both companies are based in Bavaria, Germany with Helsing so far focused on software and artificial intelligence-driven defence solutions.

Northrop Grumman has invested $50m in start up, Firefly Aerospace in order to advance the development of the latter's Advance Eclipse medium launch vehicle. Designed to carry up to 16,300kg into LEO or 3,200kg into geosynchronous orbit across civil and military applications, current plans are for the rocket to launch next year.

Radome

DEFENCE

USAF to cancel E-7 AWACS procurement?

A proposal has emerged in the next US budget to cancel the US Air Force's forthcoming E-7A Wedgetail purchase and instead pivot to using the E-2D Advanced Hawkeye operated by the US Navy. Advocates say this would be a more cost-effective and survivable way to transition from the current E-3 Sentry, the latter because the E-2 can operate from a larger number of airfields. However, trade-offs would be involved in terms of speed, as well as the smaller number of rear crew on a Hawkeye, which could impact on future mission scenarios. An interim measure like this could plug the gap until space-based solutions are mature.

SPACEFLIGHT

First images from Biomass satellite

The European Space Agency (ESA) has released the first images from the UK-built Biomass Earth observation satellite, which launched earlier this year. The probe uses P-band synthetic aperture radar (SAR) to penetrate forest and leaf canopies to measure woody biomass, such as trees and branches and, thus, calculate carbon storage.

AEROSPACE

EASA approves mixed-reality flight simulator

Swiss flight simulation manufacturer, Brunner Elektronik's new mixed-reality flight simulation training device has been recognised by EASA, marking a milestone in the adoption of professional mixed-reality training in civil aviation. The Diamond DA-42-based simulator is being developed for Lufthansa Aviation Training and uses a Varjo XR-4 Focal Edition headset designed in Finland. This blends real and virtual elements to produce a photorealistic mixed-reality cockpit experience.

AIR TRANSPORT

Orders fall following tariff uncertainty

According to data released by ADS, commercial aircraft orders dropped by almost three quarters in April 2025, compared to April 2024. Just 19 aircraft were ordered during the month, relative to 64 the previous year. The slump is believed to be related to uncertainty over tariffs imposed, threatened or retracted by the US administration. Conversely, deliveries rose by 20% to 102 in April 2025. According to ADS, the global aircraft backlog now stands at 15,871 aircraft, equivalent to around £248bn in value to the UK economy. However, speaking to reporters ahead of the Paris Air Show last month, Airbus commercial chief, Christian Scherer said he "had not seen an inflection in demand from our customers." Airbus predicts that the world's airlines will need 43,420 new aircraft in the next two decades, with rival, Boeing, estimating demand for 43,600.

NEWS IN BRIEF

The Norwegian air ambulance has placed a firm order for two Airbus H145 helicopters within a larger contract for up to eight. The organisation currently operates a fleet of 20 H135 and H145s, being the launch operator for the latter in 2020.

Collins Aerospace is enhancing its operations in the UK and France as part of the drive towards the development of electric aircraft. The RTX subsidiary will establish an engineering centre of excellence in Wolverhampton to develop next-generation electric thrust reverser actuation systems. At the same time, it will open a production line in Colomiers, France.

Türkiye's aviation regulator has announced fines for passengers who stand up before the aircraft has come to a halt and unbuckle their belts early.

Correction

In the June 2025 issue of *AEROSPACE* it was reported that New York City Council had voted to restrict 'non-essential helicopter' operations from NYC heliports. However, as well as exemptions for military, EMS, law enforcement, newsgathering and eVTOLs - helicopters "meeting stringent FAA Stage 3 noise standards" would also be excluded from the ban.

ON THE MOVE

Sabine Klauke is to step down as Airbus' CTO & EVP Engineering Commercial Aircraft to take up a new role heading Digital Design Manufacturing and Services 'Next-Gen' on 1 July. She is replaced by Rémi Maillard.

The nominee to be the next NASA Administrator, Jared Isaacman, had his nomination pulled by US President, Donald Trump. Isaacman had been Elon Musk's pick to lead the agency. No new nominee for Adminstrator has yet been announced.

RAF Chief of the Air Staff, Air Chief Marshal Sir Richard Knighton CB FREng KCB FRAeS has been appointed as the new Chief of Defence Staff, effective from September 2025. He succeeds Admiral Sir Tony Radakin KCB ADC.

News Analysis

DEFENCE

Israel unleashes IAF against Iran

Jack Richardson

Israel is no stranger to launching audacious attacks on its enemies, be this the 1976 raid on Entebbe Airport in Uganda or last year's mass pager attack. On Friday 13 June, however, the country launched one of its most daring operations yet with a multi-pronged attack on Iran, hitting targets as diverse as key nuclear facilities and the scientists that had allegedly been working to produce atomic weapons.

As the opening stage of the assault, Mossad commandos, who had been covertly inserted onto Iranian soil, launched quadcopters in order to neutralise Iranian air defence missile sites, in a similar method to Ukriane's Operation Spiderweb (see page 12). Up until this point, Iran has made extensive use of loitering munitions, such as its Shahed one-way effectors supplied to Russia in its invasion of Ukraine. Within its own industry, Israel has also been a pioneer in one-way attack munitions, bringing drones, such as the UVision HERO 120 family of loitering munitions to market. While similar weapons have proved a valuable way for Ukraine to target areas, including the Russian capital, Moscow, Israel's use of undisclosed attack drones to neutralise Iran's air defences points to how these weapons will be used going forward.

Long-range strikes

Following the destruction or suppression of air defence sites, Israel launched its main offensive against Iran's key nuclear sites using more conventional forms of air power. Unverified reports suggest that the Israeli Air Force's F-35I *Adir* fifth-generation fighters (a derivative for the F-35A conventional take-off and landing variant) had been used to suppress any remaining Iranian air defence sites, taking advantage of its stealth and sensor fusion technology. As part of this early wave of strikes, over 200 Israeli aircraft were involved. In total more than 1,200 sorties over the whole campaign were conducted with types including the F-15I and F-16I being deployed.

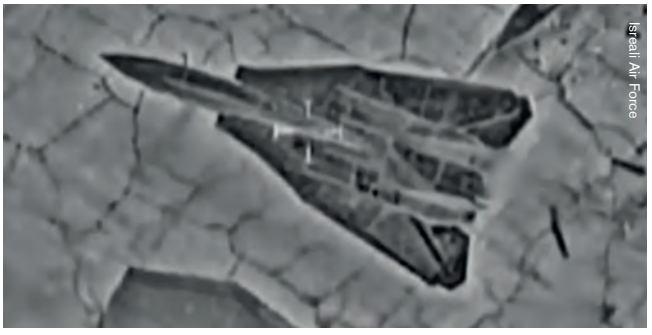
Codenamed 'Operation Rising Lion', the uranium enrichment site at Natanz and heavy water facility in Arak were reported to have been hit (the latter unconfirmed) with similar claims that the uranium conversion site in Isfahan was targeted alongside an experimental facility in Parchin. Israel has also exercised a decapitation strategy against the Iranian nuclear programme and the regime more widely. Key figures that have reportedly been eliminated include Iran's Chief of Defence Staff, Chief of the IRGC Aerospace Force and at least ten scientists working on the nuclear programme. In addition to nuclear production facilities and regime leadership, Israel has also targeted ballistic missile launchers and stocks, as well as the notorious Evin Prison, blowing off its doors in a precision air strike against the site where political prisoners and foreign dissidents have been held. Some measure of the IAF's effectiveness against Iran's missile capability has been the diminishing number of ballistic missiles that have been launched against Israel.

Israeli Air Force

An Israeli pilot preflights her F-16I *Soufa*. Note quad pack of Small Diameter Bombs (SDB)s suggesting a diminished SAM threat.

As part of Israel's efforts to gain air superiority over Iran, videos have emerged online of F-14 Tomcat and F-5 fighters being destroyed on the ground. With air supremacy achieved in around 36-48 hours, footage emerged of Israeli Heron medium altitude-long endurance UAVs operating with impunity over Tehran. There is also an image online purporting to be Israel's secretive RA-01 drone operating over the Golan Heights and, potentially, flying to Iran. This aircraft's existence has not been confirmed so details of its role are limited, but there are suggestions that the flying wing design can operate over long distances in both reconnaissance and strike roles.

Iranian F-14s (likely non-operational) were destroyed on the ground by the Israeli Air Force during Rising Lion.


Israeli Air Force

Summary

Despite the impact on Iran's nuclear sites, there are suggestions that some of the uranium it has already enriched has been moved to a different location, though this may be short of the amount required to produce a nuclear bomb. Partly as a result, the US carried out its own strikes using B-2 Spirit bombers and Tomahawk Land Attack Missiles in order to penetrate the fortified facilities. Iran has attempted to retaliate through firing one-way attack munitions, most likely the Shahed series, and ballistic missiles towards Israel, targeting the main urban centres of Jerusalem, Tel Aviv and Haifa, though almost all have been shot down by Israeli defence systems with few casualties reported.

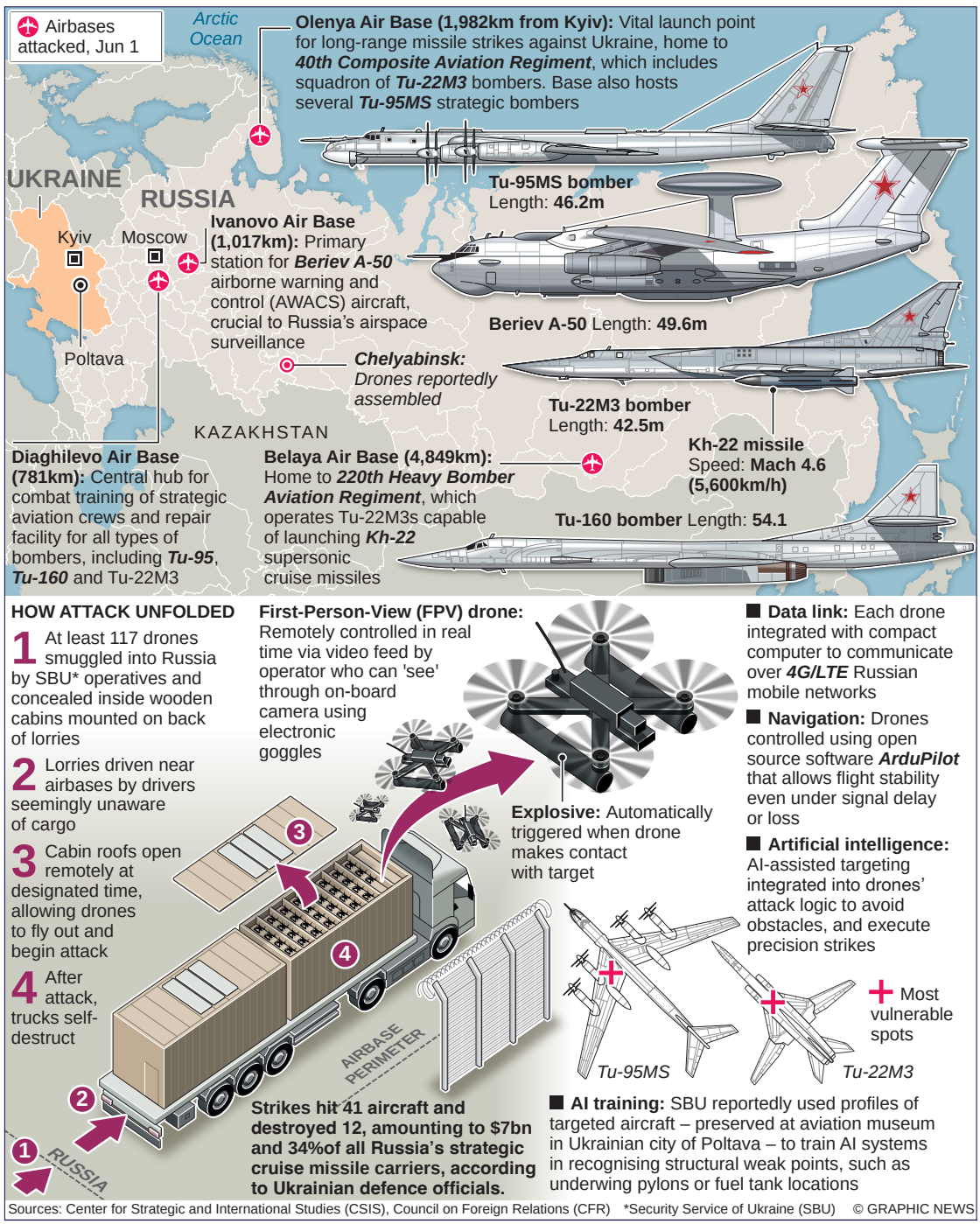
As *AEROSPACE* goes to press, the impact of the strikes upon Iran's nuclear programme, and the wider consequences for the region, and the world, remain unclear. Once again however, Operation Rising Lion has shown the proficiency of Israel in implementing an air campaign years in the planning.

By the Numbers

Understanding the world of Aerospace through data

‘Spider’s Web’ redefines asymmetric warfare

Ukraine’s Operation ‘Spider’s Web’ marks a turning point in how low-cost, improvised uncrewed systems can be employed with strategic impact deep behind enemy lines.


Airbases attacked, Jun 1
Arctic Ocean
Olenya Air Base (1,982km from Kyiv): Vital launch point for long-range missile strikes against Ukraine, home to 40th Composite Aviation Regiment, which includes squadron of Tu-22M3 bombers. Base also hosts several Tu-95MS strategic bombers
UKRAINE
RUSSIA
Kyiv
Moscow
Poltava
Ivanovo Air Base (1,017km): Primary station for Beriev A-50 airborne warning and control (AWACS) aircraft, crucial to Russia’s airspace surveillance
Chelyabinsk: Drones reportedly assembled
KAZAKHSTAN
Diaghilevo Air Base (781km): Central hub for combat training of strategic aviation crews and repair facility for all types of bombers, including Tu-95, Tu-160 and Tu-22M3
Belaya Air Base (4,849km): Home to 220th Heavy Bomber Aviation Regiment, which operates Tu-22M3s capable of launching Kh-22 supersonic cruise missiles
Tu-95MS bomber Length: 46.2m
Beriev A-50 Length: 49.6m
Tu-22M3 bomber Length: 42.5m
Kh-22 missile Speed: Mach 4.6 (5,600km/h)
Tu-160 bomber Length: 54.1
HOW ATTACK UNFOLDED
1 At least 117 drones smuggled into Russia by SBU* operatives and concealed inside wooden cabins mounted on back of lorries
2 Lorries driven near airbases by drivers seemingly unaware of cargo
3 Cabin roofs open remotely at designated time, allowing drones to fly out and begin attack
4 After attack, trucks self-destruct
First-Person-View (FPV) drone: Remotely controlled in real time via video feed by operator who can 'see' through on-board camera using electronic goggles
Explosive: Automatically triggered when drone makes contact with target
AIRBASE PERIMETER
RUSSIA
Strikes hit 41 aircraft and destroyed 12, amounting to $7bn and 34%of all Russia’s strategic cruise missile carriers, according to Ukrainian defence officials.
Data link: Each drone integrated with compact computer to communicate over 4G/LTE Russian mobile networks
Navigation: Drones controlled using open source software ArduPilot that allows flight stability even under signal delay or loss
Artificial intelligence: AI-assisted targeting integrated into drones’ attack logic to avoid obstacles, and execute precision strikes
Most vulnerable spots
Tu-95MS
Tu-22M3
AI training: SBU reportedly used profiles of targeted aircraft – preserved at aviation museum in Ukrainian city of Poltava – to train AI systems in recognising structural weak points, such as underwing pylons or fuel tank locations
Sources: Center for Strategic and International Studies (CSIS), Council on Foreign Relations (CFR) *Security Service of Ukraine (SBU) © GRAPHIC NEWS

Pushing the Envelope

Exploring advances on the leading edge of aerospace

Robert Coppinger

The wind doth blow

Airborne drones making deliveries in urban areas have been predicted for many years, but obstacles to their widespread daily use are many, with technology and certification challenges often being reported.

However, a difficulty that is not often discussed is perhaps the simplest of them all: the wind. Drones will operate at lower altitudes in urban areas, as well as taking off and landing from unprepared sites where normal wind indicators do not exist.

To remedy this, Cranfield University's Professor of Human Machine Intelligence, Weisi Guo, and his colleagues, Yifan Yang and Adolfo Perrusquía, have investigated how to use a vision system to infer wind speed and direction from a location's natural objects, such as trees and bushes.

Guo explained the inspiration for the work came from a NASA briefing he attended on future air traffic management: "This was one of the key things that they identified and no one could come up with a solution. I thought, well, how do pilots do it?"

Clues from nature

Guo thought back to the earliest days of aviation when today's technology did not exist and pilots had to glean helpful clues from their environment. In the paper, *Inferring Wind Velocity from Informal Environmental Objects using Optical Flow informed Recurrent Neural Networks*, he and his colleagues, set out their solution in the form of a vision system with machine learning (ML).

Research began about 18 months ago with the aim of finding a solution specifically for the rotorcraft, quadcopters and other multi-rotorcraft that will form the basis of the taxis and delivery vehicles operating within towns and cities. According to Guo, by applying ML to a vision system, a wide range of objects that can be seen by a drone's camera (even people's clothing) could provide those wind clues. Using a vision system also means no new hardware needs to be developed.

From the way the wind impacts these objects, the on-board computer can determine the wind velocity field around it. Guo foresees the ML vision analysis providing a traffic light system that would be a simple aid for the operator, helping with their decision to land, take off or do neither. Guo does not see this as a decision that would end a day's flying as a "lot of wind conditions are very temporary," he said. "They only last a minute."

Avoiding downdrafts

Another goal of the project is to enable operators to avoid downdrafts that can stall a rotorcraft on landing. Testing took place at the start of this year at an area of Cranfield University's campus with trees.

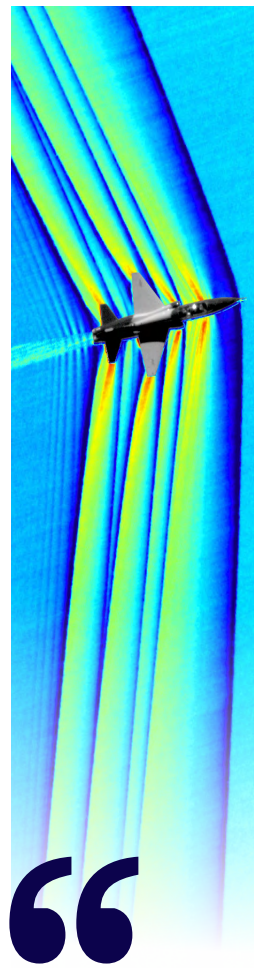
Guo explained that the next phase of the ongoing trial is to have a drone fly the technology and look at trees from various angles. The drone combines this visual analysis with the satellite-derived knowledge of its location and the direction that it is facing (from its digital compass) to find the wind velocity.

The analysis begins with the vision system learning to identify a tree, which may or may not have leaves on its branches depending on the season. It needs to learn to identify features of a tree that do not change and then it can track, for example, the changes in the position and movement of branches over a few seconds. From this, it can calculate the wind's velocity.

Guo and his colleagues are using video of trees from around the country, with different wind profiles, to teach the ML algorithms. Weather station webcams from around the UK have also been useful.

Low lighting has been studied but night-time conditions have yet to be tackled. Detecting wind vector fields can also contribute to energy efficiency, Guo claimed. Landing and taking off consumes up to 40% of a typical drone's battery capacity, he explained, so with less wind to fight against, energy can be saved.

Future testing will involve a representative 'urban canyon' to create a potentially dangerous downdraft effect. During the trial, the drone will be expected to land and take off between two or three buildings with added trees and other flora. In the tests, the drone also drops scraps of paper that will be scattered by the wind and the camera can track them to learn more about the velocity field.



> A WIDE RANGE OF OBJECTS THAT CAN BE SEEN BY A DRONE'S CAMERA (EVEN PEOPLE'S CLOTHING) COULD PROVIDE THOSE WIND CLUES

LETTERS AND ONLINE

A timely trough for transformative technologies

The recent article by my former colleague, Naomi Allen MRAeS, on aviation sustainability and the so-called 'Trough of Disillusionment' [*AEROSPACE* June 2025] was timely, thoughtful and a welcome counterpoint to the more downbeat commentary elsewhere in the same issue, particularly around the 'hydrogen bubble'.

It is incumbent on all of us to remain focused on the 2050 net zero goal. While delays and complications are frustrating and often disheartening, they do not justify abandoning the course. As Prof Mark Westwood rightly points out, the direction of travel remains sound. This is the phase where promising technologies are tested against operational, regulatory and economic realities – a crucial step on the path to maturity. We should recognise and build on the substantial evidence base created by the Aerospace Technology Institute's pioneering FlyZero programme and its follow-on work via the Hydrogen Capability Network. This unique body of research demonstrates that hydrogen can be both a technologically viable and commercially credible pathway. In particular, e-SAF derived from green hydrogen will be vital in scaling SAF use over the coming decades. We are in a necessary phase in the process of innovation. As history tells us, the most transformative technologies often emerge from precisely this point.

Scott Pendry FRAeS
Visiting Fellow, Cranfield University

HCAP to host Future Pilot Assessment Day

Applying to an Approved Training Organisation or sponsored airline programme can be a daunting task for any aspiring young pilot. The Honourable Company of Air Pilots (HCAP) has, therefore, launched a new initiative aimed at guiding prospective pilots through the process. This will be an informal course covering: an industry outlook, pilot competencies, the basics of written applications (including CVs), numerical reasoning tests, video interviews, in-person interviews, group assessments and pilot aptitude testing.

The event – which will take place at the Stelios Philanthropic Foundation in London on 18 August – will be run by industry experts who have been involved in pilot recruitment for decades utilising techniques and tests used by major airlines. Every attendee will receive tailored advice and guidance according to their personal circumstances to give them the best chance of success at an airline assessment day. There are only 12 places on the course, which costs £145 and is being run as a non-profit event – with any monies remaining after costs being used to fund flying scholarships. Aspiring pilots can book online at: www.airpilots.org.

Ben Griffiths FRAeS

Are they really 'taxis'?

Response to 'In the latest RAeS video from the Paris Air Show we speak to Adam Goldstein, Founder and CEO of Archer.'(1)

Gary Vermaak It is time to focus on the real value to society of the third age of aviation, the electric age, namely sustainable EMS, humanitarian missions and law enforcement, as well as the transport of blood and plasma and medicines, transplant organs by drone. I am frustrated that Airbus wasted time and resources on the CityAirbus multicopter when they should have focused on a RACER configuration eHelicopter, which would be far superior to any of the tilt-X eVTOLs. While the Robinson Helicopter Company electric eR is not a cleansheet aircraft, it is a step in the right direction. Plus, no matter how many times Adam Goldstein says it, the Archer Midnight is not – and will never be – a flying car (roadable aircraft) like the ASKA A5 or PAL-V.

Jamie McCarthy Current air taxis (ie helicopters) have never been more than an ultra-niche market because they are so expensive to operate and the end user has to pay that. New AAM designs will absolutely have a cost-per-seat benefit and speeds will be comparable. We are not even talking about noise benefits yet. Airbus, Bell, Robinson, Sikorsky and their like will all have a place in future vertical lift but that place has never been – and will never be – a mass-market air taxi service unless the industry develops alternatives to traditional rotorcraft designs. Simply making the prime mover electric just will not do that.

Aero vs Auto Summit

Response to 'RAeS partnered with Tech West England for the Innovations in Aerospace and Automotive Summit at No.4 during London Tech Week.'

Josef Mouris It was great to be there near the front taking part in the discussion. There is a lot to learn in aerospace from automotive when it comes to the electrifying journey. There is a huge potential but also a cautionary tale of missed opportunities.

Brize Norton's break-in

Response to 'At what point did putting all of the RAF transport and refuelling assets in a single location seem like a good idea?'

Tony Cotton As with many things, my profession (accountancy) has got involved with running things rather than just reporting the outcome. "It is cheaper and more efficient," they say. Oddly enough a business system should not have a single point of failure but it sounds like it is OK for the defence of the nation.

Paul Varcoe Are we sure they were just activists and not acting on intelligence provided from a malevolent actor? It strikes me as odd that some protestors with a paint can could just 'luckily' get through the fences, ride a scooter, spray paint, then get away unnoticed. Unless they had help.

Dave Gledhill A Hardened Aircraft Shelter is not perfect but at least it means it is one weapon per jet.

Simon Wilson All it would take is a van or truck rocking up nearby with a load of modified drones and it would be game over.

Gideon Ewers If you were to get some 'rock apes' and give them the authority to say "Royal Air Force! Halt or I will open fire" (and do not allow legal charges 40 years down the line) I expect this would not happen. But dispersal is a good idea, you can't hit what you can't find.

Pioneering heli-mail

NAL/RAeS

Response to 'On this day in aviation history, on 1 June 1948, British European Airways began the first commercial helicopter airmail service in the UK.'

Mark Young Fascinating. I've never seen a photo of a Westland Dragonfly in a civil role before. I was also totally unaware of commercial helicopter services as early as 1948!

Mike Davis And that is why I'm here. My father was with BEA Helicopters in Peterborough in '48 and that is where he met my mother.

Satellite stalkers

Response to 'Russia's newest Cosmos satellite is in orbit near an unnamed US government satellite, according to US Space Command, stoking suspicions that it is a co-orbital anti-satellite weapon rather than the neighbourhood watch bird that Moscow claims.'

Robin Trewinnard-Boyle Time for an X-37B sortie before it all kicks off *Moonraker* style in orbit!

Neuron star at Paris

Response to 'Wither FCAS? Dassault promotes Neuron 2.0 UCAV at Paris Air Show 2025.'[2]

@exotraveller We need UCAVs that are significantly cheaper and simpler. The models developed so far have largely been white elephants and too expensive to use in dangerous areas – just like our fighters.

MALE deliveries

Response to 'France selects Daher and Thales to develop a medium-altitude long endurance (MALE) drone demonstrator. That is now Eurodrone, AAROK, Aura Aero's ENBATA, SIRTAP and this – how many MALE drones does Europe actually need?'

@AlexLuck9 So France now wants to develop a spaceplane and a bunch of drones, while also developing crewed combat aircraft and a nuclear carrier. Something has got to give, no?

Raving about RACER

Response to 'Airbus RACER appears at Paris Air Show 2025.'[5]

@ValkStrategy I must say I like that thing. Only one extra spinny bit compared to a regular helo and a balanced focus on speed, range and efficiency. It would be funny if it turned out to be the right medium-speed, longer-range VTOL solution after spending billions on X2 and tiltrotor.

FCAS fracas

Response to 'Probably shouldn't read too much into this, but is it a bit odd that Franco/German/Spanish 6th gen FCAS/SCAF mock-up is hidden around the corner at Dassault while Rafale & UCAV are centre stage?'

@Artisium You should. Rafale and Neuron are Dassault's present and immediate future and more. SCAF is only a more and more distant possibility.

@XX28658231 Well, considering Airbus and Dassault, as well as Germany and France, are currently fighting bitterly – what is there to present?

@Gabbento Not odd at all, it reflects the reality. Dassault has little faith in FCAS as long as governance and workshare remain a mess. They're showcasing what works, not a stalled political compromise.

@tohonourglory Another French-German project that will never see reality?

@Gerard_Rouille It is dead. Working with Germans is impossible. We have no shared objectives. We are only competitors with two bloody World Wars between us. I do not trust Germany.

@ks13735 The French want a larger share of the programme than money they provide and they want total control of it. This is not fair for Germany and Spain. It is difficult to work with such terms. Enough is enough.

@How_Tiny_UK_Is France will soon ask Dassault, Safran, Thales and MBDA to design a 100% French 6th gen fighter with 100% French loyal wingmen.

Ukraine's Spider's Web

Response to 'Ukrainian Spider's Web strikes on multiple Russian airbases involved more than a year and a half of planning – is anyone else thinking back to the recent mystery drone incidents at RAF Lakenheath, Mildenhall and Marham?'

@CyranodEcosse Going further, the aggressive consolidation of the Defence Estate arguably leaves HM Armed Forces vulnerable to similar attacks on air bases, barracks and depots.

@Chris1872RTID It makes me worried. I assume RAF bases have little defence from a similar air attack?

@stopclimbFL200 What worries me more is a trailer of these opening up under the RWY 27 arrivals for LHR.

@mattfle02898557 By tea break today, every RAF aircraft better be either inside a HAS or protected by Hesco bastions and netting.

@TheArisen01 Bases need effective anti-drone defences, both passive and active.

And the winners are...

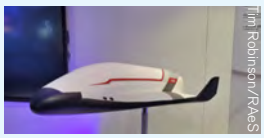
On 15 June, aviation media from around the globe gathered at the Aero Club de France in Paris for the 2025 Aerospace Media Awards.

During the evening *AEROSPACE* Editor-in-Chief, Tim Robinson was presented with a Judges' Commendation in the Best In-Depth Submission for the 'Boom boasts supersonic success with XB-1' feature[3] that he co-authored with Joe Coles. Meanwhile, Deputy Editor, Stephen Bridgewater, was awarded Best Sustainable Aviation article[4] for his feature 'Scaling up SAF.' Both articles appeared in the March 2025 edition of *AEROSPACE*.

Lancaster flies home for 80th

Eighty years on from when she was built at Broughton airfield in Cheshire, Europe's only airworthy Avro Lancaster – the RAF Battle of Britain Memorial Flight's PA474 – flew back to the site on 30 May to mark her birthday. From wings of war to supplying half of the world's airliner wings, Broughton is now the location of an Airbus factory and remains at the heart of UK aerospace manufacturing. PA474 has now been operated by the BBMF since 1974, having been rescued from scrap by 44 Sqn in 1965.

VORTEX envisioned



Response to 'Europe getting serious about improving access to space? Dassault Aviation displays VORTEX spaceplane at Paris.'

@stromgade Dassault has been pushing spaceplanes for 20 years with nothing to show for it.

@RandomRambler15 It looks like Hermes and HOTOL had an offspring.

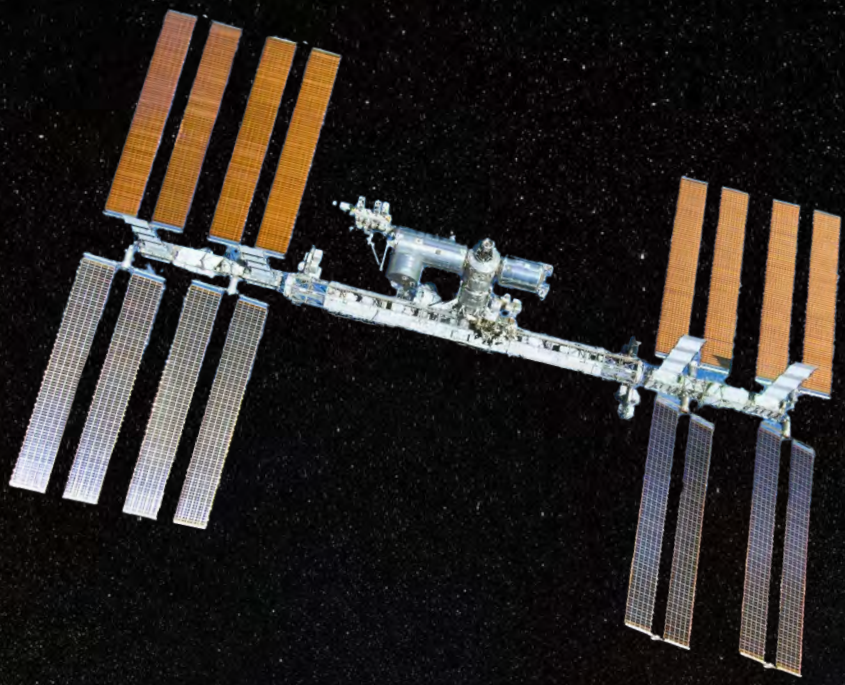
F-35 by the numbers

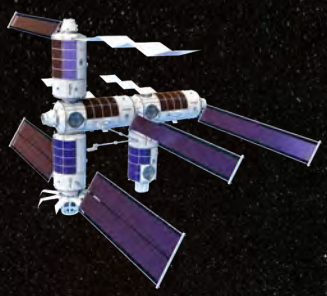
Response to 'F-35 in stats: 1m flight hours, 3,000 pilots and Lockheed says it is set to deliver 170-190 aircraft just this year.'

@sjp32wiz7 The UK aircraft still only have Paveway bombs. As the only Tier 1 partner we should demand (pay for) a deal similar to Israel and get the weapon integration done ourselves.

@simon_puxley They should add (and be proud of) ejections/crew saved. Amazing that the crew to maintainer ratio is still 1:6 though.

1. youtu.be/dKUENC6zvZE?si=tCcLd0c92fliVnPE
2. aerosociety.com/news/paris-air-show-2025-day-one/
3. aerosociety.com/news/boom-boasts-supersonic-success-xb-1
4. aerosociety.com/news/scaling-up-saf/
5. youtu.be/G90vmSCg5N4?si=cfLC0nZ2mowDN9-E





Beyond the ISS

NASA's bold shift to

With plans to de-orbit the International Space Station by 2030, **JOYCE ABAÑO** looks at the options to replace the orbital outpost.

After more than two decades in orbit, the International Space Station (ISS) is nearing the end of its operational lifespan.

The orbital outstation has hosted continuous crewed operations since 2000, enabling over 3,300 scientific experiments and serving as a platform for research, technology development and international collaboration.

However, mounting maintenance costs have made its continued upkeep[1] increasingly unsustainable, prompting NASA to plan for its de-orbit by 2030.

When that time comes, more than $100bn[2] worth of hardware will re-enter Earth's atmosphere in what may become the most expensive fireball in history, with remaining debris expected to crash into the Pacific Ocean.

De-orbiting options

NASA considered several options[3] for decommissioning the ISS but, ultimately, ruled them out due to technical, financial and safety concerns. While the idea of preserving parts of the station was explored, dismantling the ISS in space is impractical. The structure was not designed for disassembly, and returning large modules would require a shuttle-class vehicle that no longer exists. Only small items may be preserved for museums.

Moving the ISS to a higher orbit for long-term preservation was rejected due to major challenges. Such an effort would need large amounts of fuel, new vehicles, and pose higher collision risks with space debris. Extended orbital lifetimes would also increase the chance of catastrophic impacts, potentially jeopardising access to low-Earth orbit (LEO).

Letting the ISS de-orbit naturally was also considered, but the space agency said the option could endanger people on Earth due to uncontrolled re-entry of large debris. Eventually, NASA chose controlled re-entry into a remote part of the Pacific Ocean or Point Nemo as the safest, most feasible option.

△ Main image: The ISS has hosted continuous crewed operations since 2000 and NASA now plans to de-orbit the space station by 2030. NASA

△ Axiom's Hab One provides four crew quarters. as well as research space. Axiom

commercial space stations

In June 2024, NASA awarded Elon Musk's SpaceX up to $843m[4] to safely de-orbit the space station by 2030. The plan involves SpaceX building a spacecraft to dock with the ISS and guide it back to Earth. While SpaceX will build the craft, NASA will operate it during the mission, and both the ISS and vehicle will burn up during re-entry.

Earlier this year, Musk suggested on X that the ISS should be de-orbited "as soon as possible," ideally within two years, saying it has served its purpose and resources should shift to Mars missions. This would be years ahead of NASA's 2030 retirement plan and Russia's 2028 timeline to commence work on the first phase of its own orbital space station.

△ VAST's Haven-1 is intended primarily as a research platform. (VastSpace)

SpaceX contracts at risk

However, the recent public feud between Musk and US President, Donald Trump is complicating matters and could put billions of dollars in SpaceX contracts at risk, upend NASA missions, Pentagon launches, Moon landings via Starship, spy satellite launches and the future of US spaceflight.

The clash began after Musk condemned Trump's 'One Big Beautiful Bill' (a proposed tax cut plan that could add $3trn to the national debt), calling it a "disgusting abomination." The tensions escalated with Trump threatening to cancel SpaceX's government deals.

Musk, in response, briefly vowed to decommission SpaceX's Dragon capsule – NASA's primary crew transport to the ISS – before retracting his threat. Analysts say SpaceX could weather the storm, thanks to its dominance in the commercial space sector, but any loss of government contracts would mean billions in missed opportunities. Former NASA officials warn that political retaliation and threats to vital space infrastructure could have serious legal and safety implications.

Uncertainty at NASA

The Trump administration has also created concern for NASA with its proposed slashing of the agency's budget and unexpectedly withdrawing Jared Isaacman's nomination as NASA administrator.

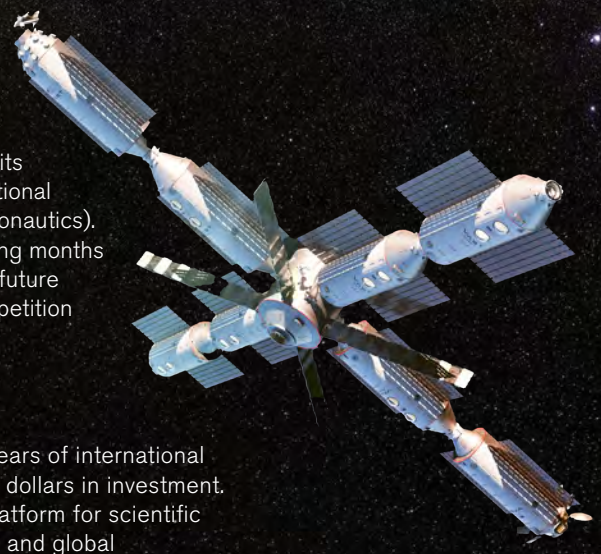
The proposed 2026 budget would cut NASA funding from $24.8bn to $18.8bn – the lowest (inflation-adjusted) level since 1961 – and eliminate key programmes, including the Mars Sample Return, Venus missions and even the Space Launch System (SLS) and Orion spacecraft once the Artemis III mission concludes in 2027.

The plan shifts focus to commercial spaceflight with SpaceX and Blue Origin leading Moon-to-Mars efforts, while also proposing a one-third reduction in NASA's workforce. Space science advocates warn the cuts could cripple NASA's research capabilities.

Meanwhile, Isaacman's withdrawn nomination leaves NASA without a leader during a critical time. His replacement must go through a lengthy confirmation process, likely leaving the agency in limbo for months.

Long-term, NASA may need to redefine its mission if commercial partners take over human spaceflight. It could shift toward advanced research and development, similar to its predecessor NACA (the National Advisory Committee for Aeronautics). Decisions made in the coming months will determine the agency's future direction amid growing competition from the private sector.

▽ Construction is under way on Axiom's Hab One. Axiom



Replacing the ISS

The ISS was a product of years of international co-operation and billions of dollars in investment. It has served as a crucial platform for scientific research, astronaut training and global collaboration.

Gateway Foundation

◁ The commercialisation of space offers numerous opportunities, not least orbital tourism. As far back as 2012, the Gateway Foundation announced plans to open the first hotel in space. VERA (Voluminous Environment, Rotating Architecture) will reportedly accommodate 1,000 guests and 200 crew.

With around $3bn in annual operating costs[5], the orbiting laboratory accounts for nearly a third of NASA's human spaceflight budget. Maintenance and upgrade costs continue to rise, reaching $169m in 2020, mainly due to system upgrades and, in January 2024, the space agency selected 12 companies to provide research, engineering and mission integration services under the $478m REMIS-2 contract, supporting the ISS through to at least 2030.

While replacing the ISS would be a daunting task, it is one that NASA seems well-equipped to take on. The agency has shifted its focus towards supporting the development of commercially developed space stations to carry on the ISS' legacy.

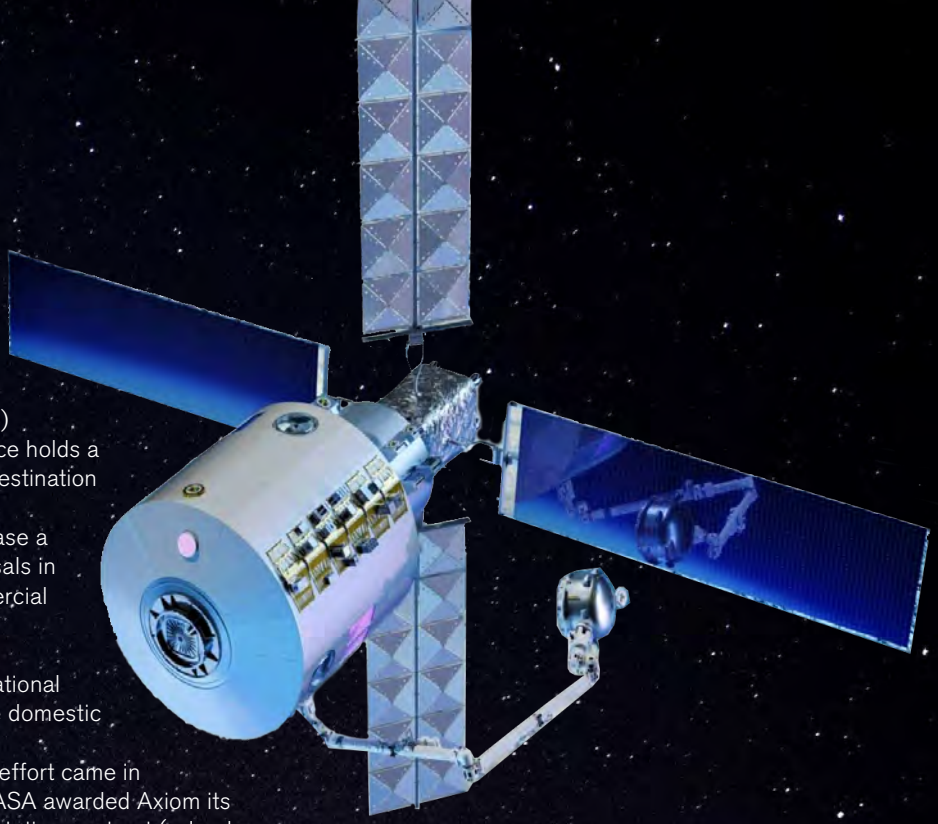
Companies, like Blue Origin and Sierra Space (Orbital Reef), Nanoracks and Voyager Space (Starlab), Northrop Grumman and Axiom Space, are developing next-generation stations to support research, industry, tourism and government missions in LEO.

These efforts mark a transition to a more commercially driven future in space with NASA planning to pay for services as a customer rather than running everything.

Commercial space stations

Transitioning to such commercial platforms[6] allows the agency to focus on deep space missions while still maintaining a robust LEO presence. NASA is supporting this shift through its Commercial LEO Destinations (CLD) programme, aiming to lease access to these private stations rather than owning and operating a government-run platform.

To support the development of safe and affordable commercial space stations, NASA awarded early-phase contracts. Blue Origin and Starlab Space hold Commercial Destinations Free Flyer (CDFF) agreements, while companies, like



◁ VAST is developing Haven-1, the first commercial space station, which is scheduled to launch in 2025. VastSpace

▷ VAST plans to have a larger Haven-2 space station operational by 2032. VastSpace

Northrop Grumman, Sierra Space, SpaceX and others, received awards under the Collaborations for Commercial Space Capabilities-2 (CCSC-2) programme. Axiom Space holds a separate Commercial Destination ISS (CDISS) contract.

NASA plans to release a draft request for proposals in 2025 to buy full commercial LEO services, aiming to contract with US-based providers, supporting national policy to strengthen the domestic space industry.

A major step in this effort came in January 2020, when NASA awarded Axiom its first commercial space station contract (valued at $140m) to build ISS-attached modules that will later form a stand-alone station. In December 2021, NASA went on to fund three more commercial space station concepts, awarding $415.6m in contracts to Blue Origin (including $160m for Orbital Reef), Nanoracks, which received $160m for Starlab, and Northrop Grumman, which was awarded $125.6m.

A second round of contracts for station services will be awarded in FY 2025, with up to two winners selected from a broader pool beyond these four companies.

Progress to date

Axiom Space originally planned a four-module station but scaled this down to two due to financial challenges. The first module, Axiom Hab One (AxH1), is scheduled to dock with the ISS in 2026, eventually forming the stand-alone Axiom Station free-flying commercial space station.

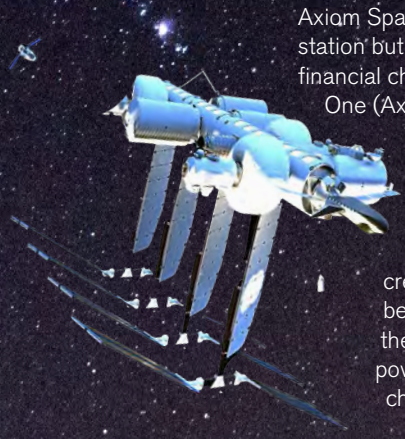
In December 2024, Axiom changed its assembly plan to speed up the creation of Axiom Station. Originally set to begin with a habitat module attached to the ISS, the updated plan launches a power and thermal module first. This change allows Axiom Station to operate independently as early as 2028, well before the ISS retires.

NASA and Axiom say this new approach helps reduce reliance on the ISS during assembly and ensures a smoother transition to commercial space operations in LEO. Axiom Station will continue expanding with additional modules after becoming free-flying.

Meanwhile, aerospace firm, VAST is developing Haven-1, the first commercial space station, which is scheduled to launch in 2025. A larger follow-up, Haven-2, is planned for completion by 2032.

Orbital Reef, the joint effort by Sierra Space, Boeing and Jeff Bezos' Blue Origin, is moving forward, despite internal issues and the multi-module station is reportedly on target to launch in 2027. The planned outpost is designed to accommodate up to ten crew members and provide roughly 90% of the ISS' habitable volume.

Elsewhere, Starlab is backed by Voyager Space (recently rebranded to Voyager Technologies), Airbus, Mitsubishi Corporation and Northrop Grumman. The project will be launched in one piece via SpaceX's Starship in 2028 and will be resupplied by Northrop Grumman's Cygnus cargo spacecraft.



△ Orbital Reef's multi-module station is a joint effort by Sierra Space, Boeing and Blue Origin. It is reportedly on target to launch in 2027. Orbital Reef

▷ Orbital Reef's is designed to accommodate up to ten crew members.

△ China's Tiangong space station launched in April 2021 and is now constantly crewed by a rotating three-person crew. China Space Agency

Economic opportunities

Commercial space stations will generate revenue[7] by offering services, like microgravity research, space tourism, in-space manufacturing, biotech, data services and other innovative ventures to various nations, acting as platforms for international collaboration.

They will also enable companies to develop business models in orbit, potentially opening a new economic frontier with key sectors where commercial activity could thrive including:

Pharmaceuticals: Drug development and protein crystallisation behave differently in microgravity, enabling new breakthroughs in treatments.

Advanced manufacturing: Commercial space stations will enable the space-based manufacturing of high-performance materials, such as fibre optics, alloys and semiconductors.

Biotech: Private stations can support biotech by accelerating research on stem cells, organoids and tissue engineering.

Earth observation: Stations can host sensors for climate and environmental monitoring, agriculture and disaster analysis, as well as commercial remote sensing for the likes of infrastructure and shipping.

Space tourism and media: Commercial space stations can boost space tourism and media by enabling private missions for wealthy individuals and researchers, as well as creating new opportunities for filming and live events in microgravity.

Security and defence: Private stations can support security and defence through surveillance, space domain awareness and in-orbit testing of defence technologies.

Space-based computing: Commercial space stations could enable space-based computing, hosting future data centres that take advantage of solar power and natural vacuum cooling.

In recent years, other countries have launched, or expressed interest to create, their own space stations. In July 2022, Russia's federal space agency, Roscosmos, announced that the country would commence work on the first phase of its own orbital space station in 2028 and start on the second phase around 2030. China launched the first module of its Tiangong space station in April 2021 and the structure was completed in 2022. Operated by the China Manned Space Agency, the space station has three modules and a rotating three-person crew.

The race to replace the ISS is now well and truly on.

Refences
(1) https://www.nasa.gov/wp-content/uploads/2024/06/iss-deorbit-analysis-summary.pdf
(2) https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/International_Space_Station/How_much_does_it_cost
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(4) https://www.nasa.gov/news-release/nasa-selects-international-space-station-us-deorbit-vehicle/
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Out of Finnair

Marking a year since he took over as CEO of Finnair, Turkka Kuusisto visited London to discuss the threats and opportunities faced by an airline based adjacent to Russia's closed airspace. **STEPHEN BRIDGEWATER** FRAeS reports.

Almost a year to the day since taking over as Finnair's CEO, Turkka Kuusisto, was the guest of honour at a lunch hosted by The Aviation Club UK at the Royal Over-Seas League in London on 30 April.

The son of a Finnair pilot, Kuusisto has a long history at the helm of successful businesses, not least the Finnish postal service. However, running the fifth oldest surviving airline (101 years old this year) has not come without its challenges and, in an enjoyable fireside chat, The Aviation Club UK's James McCarthy dug into what Kuusisto had learnt in his first 12 months at the airline.

So close to Russia

Finland is in a unique geographical position, sharing a border with Russia but now effectively what Kuusisto referred to as "an island," following the closure of Russian airspace due to its ongoing military aggression in Ukraine.

Although the invasion predated his time at Finnair, Kuusisto discussed the initial effect it had had on the airline. "We were just bouncing back after the pandemic and preparing to relaunch the pre-Covid services that provided the shortest connections between Europe and Asia," he told the audience. "We were looking forward to near 2019 levels of demand but then faced another unforeseen existential crisis."

The airline's priority was to take immediate action to secure the safety of employees and crew and many of its aircraft were grounded immediately. "Many of our long-haul flights towards Asia leave during the evening," Kuusisto explained, "and in a very short period of time, the decision was made to cancel all those flights. Only thereafter could we start to evaluate the effect of the so-called New World Order and plan to reconstruct the airline's strategy."

Many airline leaders are pessimistic about the possibility of Russian airspace opening in the near to medium term. When pressed on the matter, Kuusisto described himself as "a realist, not a pessimist," pointing out that "there was speculation about the opening of Russian airspace when the so-called Ukrainian peace process was first discussed but, unfortunately, very little has happened since."

"My very decisive guidance to my organisation has been to ensure that our strategy, commercial approach and network design must contribute value, even if Russian airspace remains closed. If it opens, then it is a positive booster for our current business model and strategy – but one needs to be very realistic."

Stephen Bridgewater/RAeS

◀ Finnair CEO, Turkka Kuusisto (left), with The Aviation Club UK's James McCarthy at the Royal Over-Seas League in London on 30 April.

▼ From its base at Helsinki Airport, Finnair now reaches around 100 destinations worldwide.

However, he went on to explain that Finnair would be able to react very quickly if Russian overflight rights are restored and the most immediate benefit would be that the airline could return to providing 24-hour rotations, flying its A350s from Helsinki to Asia.

Financial success

Ever the pragmatist, Kuusisto sees that reset as a way to achieve a more balanced network. "While Asia is still extremely important for us, at the same time we have become a much more important operator on the North Atlantic traffic routes."

The strategy seems to have worked, with Kuusisto reporting that Finnair's 2023 financial figures were very good. "In fairness it was pretty much a good year for all companies," he accepted. "There was a lot of backlog after the pandemic with ticket prices and demand both extremely high but, at the same time, we feel that we did a very solid job in 2024, even though the ticket prices and yields started to normalise. So, we have two solid, robust fiscal years behind us."

"The first quarter results for 2025 are a bit of a weak start," he admitted, "but in many ways that was expected and hampered by prolonged industrial action. All in all, I would say that Finnair is back in the game and back to cruising altitude."

How has Finnair achieved this turnaround, weathering the storm from what could have been a tumultuous commercial disaster to a healthy 'new' business? "It is all about attitude, agility, willingness and what we call in Finnish 'sisu' – I guess the best translation is 'determination.' The Finnair force really has 'sisu,'" Kuusisto proudly told the audience.

However, the ongoing strike for better wages by members of the Finnish Transport Pilots' Association (SLL), which began in the autumn of 2024, continues with action, including a standby ban. The airline has not ruled out furloughing staff as a result of the industrial action and Kuusisto confirmed that it has had to cut some 230 flights from its summer schedule as a direct result of the strikes.

> "FINNAIR WOULD BE ABLE TO REACT VERY QUICKLY IF RUSSIAN OVERFLIGHT RIGHTS ARE RESTORED

Atlantic reliance

The growing reliance on North Atlantic traffic could be subject to turbulence in the months ahead, with volatility in the financial markets, following uncertainty over tariffs and reports of a growing unwillingness among Europeans to travel to the US in response to concerns over various Trump administration policies. However, at the time of speaking, Kuusisto said Finnair had not yet seen a drop-off in bookings. "It is too early to tell and we now follow the trend on a weekly basis but, so far, we have not witnessed a big shift in either consumer behaviour or demand."

"We are continuing our investment in the transatlantic market," he continued, "and for the forthcoming summer season we will be flying 11 weekly frequencies from Helsinki to Dallas, for instance. Unless something extraordinary happens we will continue to invest in the US market."

Fleet renewals

In 2025, Finnair operates a predominantly Airbus fleet of 80 aircraft. This includes A319s, A320s, A321s, A330s and A350s but its regional operations are supplemented by 12 ATR 72-500s and 12 Embraer E190s. In a February earnings call, the airline communicated the fact that it was about to begin evaluating options to replace 15 of its narrowbody Airbus types.

"Those aircraft are coming to the end of their life cycle with an average age of 23 years," confirmed Kuusisto. "So, during this calendar year, we need to make at least preliminary decisions about how we approach this renewal. Due diligence work is being conducted now and it all starts with our network design team. I asked them for an optimal network

for Finnair to fly in the future to support both our core strategy and commercial strategy. Once we have that in place, we will select the most suitable aircraft to fly that network."

A newer generation of aircraft will also help Finnair meet its sustainability targets. However, Kuusisto referred to the attitude towards sustainability as "perhaps my biggest surprise since joining the airline."

"It is a complicated topic because aviation companies should obviously do their fair share when it comes to fighting the climate crisis," he elaborated. "But at the same time, we need to be humble and realistic about what we can do with what is available in our toolbox. The affordability and availability of sustainable aviation fuel will most likely become a bottleneck towards the end of this decade and we need to understand that fitting solar panels on top of our offices and switching to LED bulbs is not going to help if we are not capable of solving the fuel issue."

That said, he confirmed that Finnair remained committed to its Science-Based Targets Initiative validated CO_2 reduction targets, which call for a 34.5% reduction in CO_2 intensity by the end of 2033. "It's a very ambitious target," he admitted, "and we most likely do not have all the tools available yet, so we need to maintain the technological developments. Above all, we need to accept that the development curve will not be linear and some type of revolutionary technologies will need to emerge."

> "WE NEED TO UNDERSTAND THAT FITTING SOLAR PANELS ON TOP OF OUR OFFICES AND SWITCHING TO LED BULBS IS NOT GOING TO HELP IF WE ARE NOT CAPABLE OF SOLVING THE [SUSTAINABLE] FUEL ISSUE

Kuusisto also urged against overregulation, saying "we need to secure the connectivity and competitiveness of the European carriers. For Finland – which is a small country with just 5.6m citizens – to remain competitive and relevant we need reliable and cost-effective connections to Europe."

The fact that the airline's CEO was so hands-on with the running of the operation was evident when he explained how he makes a point of sitting in on the quarterly safety management and safety culture calls. "The previous CEOs had not done this," he revealed, "but, for me, it is a window into the attitude and the pulse of the organisation. I find it heartwarming to hear the level of details and diligence our team is putting into the step-by-step process of flight safety. I guess, in an airline company, the biggest threat is actually when you have been so good previously that you become complacent – but the Finnair team is always pushing for better, safer performance."

"On that theme, I feel that regulators and airlines should only stipulate processes and procedures that are fit for purpose – and that operators need to not just stick with them but work towards improving them and creating an extremely robust management system. Meanwhile, we should also get rid of all the non-necessary bureaucracy."

Recipe for success

In recent years, Finnair has been recognised as the 'Best Airline' in Northern Europe by World Airline Awards for the 14th time and also won 'Best Cabin Crew' in Northern Europe in 2023.

"There is something magical that my colleagues do in the cabin during the flight," Kuusisto proudly told the audience. That is pretty much the heart of the service and operation that we provide for our customers. Of course, I am aware that we need to become better when it comes to the digital experience, as well as the before and after-flight experiences – but, when we really dive into the core product, it's all about the reliability and punctuality of our service and excellence of our cabin crew."

Kuusisto sees AI as the key to future successes. "Our operations must become more intelligent and be backed up with both data and AI," he explained. "But, at the same time, I believe that we have a lot of potential when it comes to improving the user interface with our customers and passengers. Our mobile app will be key to our digital development, and not only for the core parts of passenger travel. We are looking at what else we could bring into the app, especially for our Finnair Plus loyalty scheme members. During the years to come, you will see great things coming up through our digital pipeline."

At present, Finnair is operating the A350 from Helsinki to London but Kuusisto was asked whether any thought had been given to a Stockholm to London City route, using one of Finnair's narrowbody types. With 1.3m passengers flying between the two cities annually, the Finnair CEO agreed that it was an avenue that was being explored.

He also acknowledged that the volatile nature of geopolitics presented his airline with a mix of both threats and opportunities. "We are still feeling the 'positive' after-effects of the pandemic," he explained. "Those with the available funds are still prioritising travel – particularly in the premium leisure travel market. We are continuously developing our premium offering and network and

◀◀ Finnair now operates 80 aircraft to around 100 destinations worldwide.

▲ Kuusisto described his workforce as the airline's biggest asset.

◀ A dozen ATR 72s are among the few non-Airbus aircraft in the fleet.

All images via Finnair unless stated.

we believe that we could be the real champion in the Nordics. For instance, this summer we are offering 54 weekly frequencies from Finland to Norway and it is important to understand the attractiveness of the Nordic region during the summertime – it is not all about Lapland and Santa Claus and winter snow – there are exotic places to visit during the summertime."

Staying humble

In an era where airlines are increasingly merging to improve their competitive dynamics, Kuusisto was asked whether this was on the cards at Finnair – which is already part of the oneworld alliance.

"My core principles for Finnair are based on two things," he elaborated. "Firstly, we have to assume that Russian airspace will remain closed for the foreseeable future and, secondly, we need to develop a sustainable stand-alone company. That said, we get a huge benefit from being a member of the alliance, but we need to stay extremely humble. At best we are a medium-sized airline company with around 100 destinations and a fleet of 80 aircraft but, through our partners and alliances, we can actually reach 1,000 destinations globally."

"Over my first 12 months, I've learned that Finnair is actually a very valued oneworld member and partner. Even though we are not the biggest in terms of fleet size or network size, we definitely punch above our weight when it comes to being a value creator in the ecosystem."

Kuusisto says he has learnt a lot during his first year at the helm of Finland's flag carrier but none of it came as a surprise. "There is a sense of pride associated with this brand; you can almost touch it," he said with a beaming smile. "To some extent it is a calling to be part of an airline, at least in Finland. Finnair has come through difficult times but I have an extremely resilient and agile group of magnificent colleagues and I am really looking forward to taking this company to the next chapter."

The man who hid warplanes

Aviation artist, Keith Ferris has had a greater impact on aircraft camouflage than anyone else. **JOE COLES** speaks with him about a stellar career.

According to Keith Ferris, the function of aircraft camouflage is "to screw up the air battle." Ferris was motivated by a desire to save lives; his own experiences from the cockpit in Southeast Asia contributed to this obsession, but the story began long before. Ferris had aviation in his blood from childhood, courtesy of his father's career as a USAAC pilot.

"I flew for the first time on my 10th birthday in a B-18 Bolo bomber," he recalls. "It was 1939 and my dad flew from 1925 to 1955. I spent my whole life moving from base to base and I was out on a flight-line by the age of four. My goal was to be in the USAF, but it wasn't to be. When I saw my first jet fighter, I went straight to the Flight Surgeon to see if I could sign up. [However] I had some extreme allergies, which meant I couldn't take many of the shots required in the military. So, in effect, I was 'drafted' into civilian life."

Heartbroken by his inability to become a pilot, Ferris used his other love (art) to get closer to the action. "I joined the Society of Illustrators, which has an Air Force programme where artists participate in missions and document them with paintings. The first thing I did was cover a T-38 instructor pilot course and I got checked out in the T-38 in 1963 and flew the syllabus. From then on, I got to fly military jets anytime I got sent from the USAF to cover something as an artist and I had a T-33 available for five years, accompanied by an instructor pilot who took me anywhere I wanted."

Backseat adventures

He then took what must be one of the most dangerous jobs in the arts – flying backseat in F-4 Phantoms and F-105 Thunderchiefs over war-torn Southeast Asia, with a camera and sketchbook in the cockpit to record what he saw. "I deployed with a fighter squadron to Thailand," he explains. "As the backseater in an F-4 you weren't just an artist – you also had to handle radars, weapon systems, radio frequencies, etc. I flew the F-4D and then the F-4E on operational missions, but I didn't go into Vietnam as they didn't want a civilian to be shot down. So, I chased the missions to Laos. The only combat encounter that I had was on a B-52 strike out of U-Tapao, targeting the Mụ Giạ Pass, which was protected by SAMs and anti-aircraft guns."

Everything fades to grey

In November 1968, while flying in an F-4E Phantom from Hickam AFB, Hawaii to Korat RTAFB, Thailand, he had a revelation. The Phantoms and their tankers, with their green and brown upper-painted surfaces, were horrifically conspicuous – making ripe juicy targets for enemy MiGs.

This terrible camouflage was costing lives but, as an artist, he knew he could solve this problem. Ferris vowed there and then to develop better schemes that tricked the eye and gave aircrew a greater chance of survival, giving pilots an edge in visual air-to-air engagements.

When creating paintings of WW2 Luftwaffe fighters, Ferris had to minimise the camouflage of the aircraft to make the form of the aircraft clearly visible and he eventually realised this was telling him there was something very special about these schemes. The Germans began the war with camouflage designed to hide in trees. However, experience gained in fighting in Poland led to schemes better suited for hiding in the sky. Greys were better and a darker upper grey could reduce the amount of 'sun flash' betraying an aircraft's presence. Ferris realised that this countershading, combined with smaller sections to break up the shape, was the best fighter scheme of the war and he developed a new system, building on both historical research of Luftwaffe wartime schemes and his experience as an artist and pilot.

In a 1976 *Top Gun Journal*, which is now declassified, he revealed his revolutionary thinking. Key was the near-magical properties of the colour grey. "No matter what colour it is, the further away it gets from you, it turns to a grey," Ferris' article noted. "These green trees I'm looking at, when they go out there a mile or so are turning to grey. The value, the darks get lighter with distance; the lights get darker. A white will be turning to a grey and the dark will be turning into

> "KEY WAS THE NEAR-MAGICAL PROPERTIES OF THE COLOUR GREY

▲ A model of an F-22 Raptor in a 'Ferris System Averaging' scheme.

Main image: Some F-4 Phantoms were painted in a Ferris scheme. Note the angular scallops, designed to reduce sun highlights on the top surfaces. The lightest paint is to be seen below the scallop and any surface to be viewed from 90 degrees to the vertical or below.

grey, so they both are the same grey and then they disappear. That's the way your eye works."

This is the reason we see grey as so lacking in vibrancy and the exact reason why it is the best camouflage colour.

Which way is up?

As well as making yourself hard to see, confusing an enemy (or enemies) as to which way up you are can cause a second or two of doubt at a moment where such hesitation can cost a life. The false canopy is a brilliantly simple piece of deception camouflage and is similar in principle to the eye-like shapes on a butterfly's wings. The false canopy is simply a dark shape painted on the underside of an aircraft, positioned in the same way as the actual canopy. Ferris notes: "There is deception in everything we do in this business, like magicians."

Though the Marines and Navy were receptive to his ideas, as an outsider, Ferris was met with some hostility at Nellis AFB, even when the scheme, complete with false canopy, proved brilliantly effective in tests. "Out at Nellis, they tested my paint scheme, they found that 3.7% of encounters resulted in mistakes," he recalled. "Then, the Marines conducted a test, and they found that 37% of all encounters resulted in mistakes. Nellis had moved the decimal point! They didn't want to admit it because of a 'not-invented-here' bias."

Not only was the fake canopy concept a secret, it was patented. When a USAF A-10 carried it without permission at the Paris Air Show, it was an expensive mistake. "The guys that I briefed at the A-10 special projects office had painted the canopy on the bottom and took it to the airshow – that was a hundred-thousand-dollar mistake because they were fined for it!"

Canada adopted and paid for false canopies for its F/A-18 Hornets and the Italian Navy's Harriers and some USAF A-10s also adopted it. When asked why it had not been universally adopted, Ferris wondered if it was due to a lack of awareness of the concept and a misunderstanding of the idea (it is not primarily for 1-V-1 but rather a 2-V-1 advantage). Further evidence that it works comes from multiple reports of near collisions.

Questioned on the function of aircraft camo, Ferris replies succinctly that it was "to screw up the air battle" and "to make it difficult for people to track what's going on in a multi-aircraft combat situation." Camouflage conceals, deceives and confuses both the shape, direction and attitude of an aircraft.

Dazzlingly average

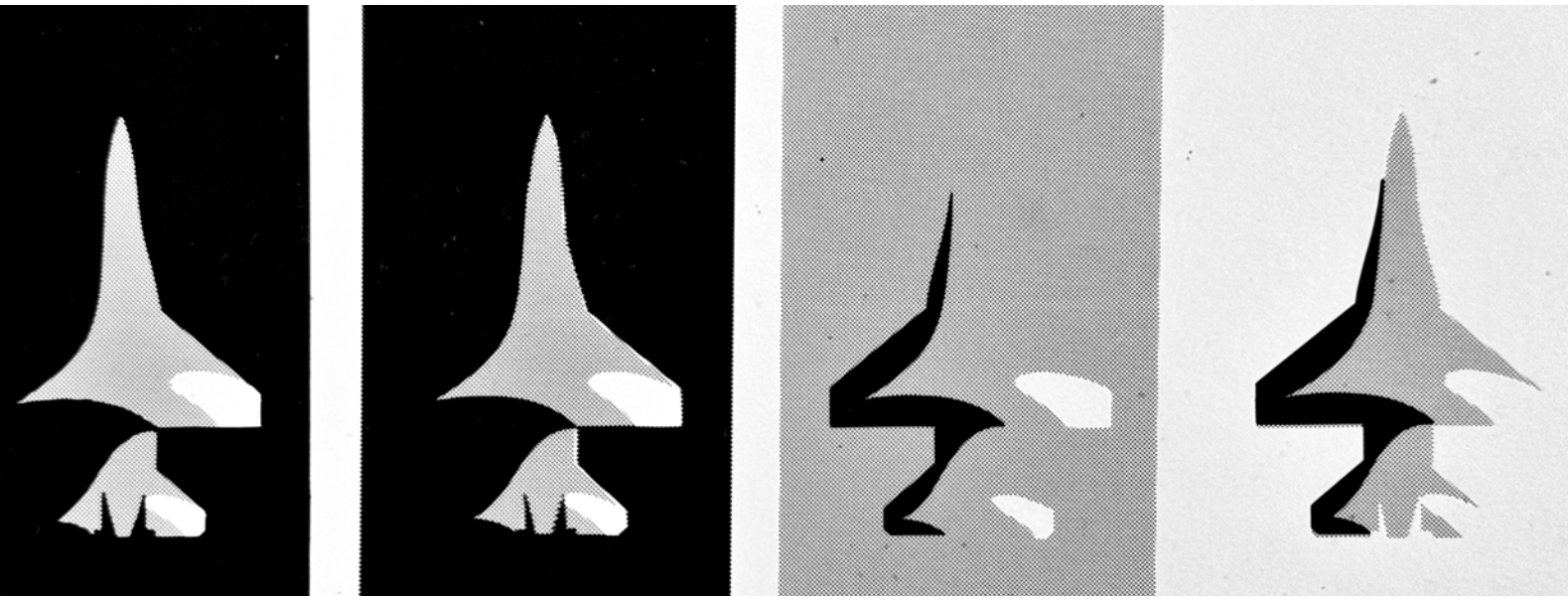
During the interview, Ferris demonstrated a model of an F-22 Raptor in a 'Ferris System Averaging' scheme. The mathematics used to calculate the colours and edges of this scheme remain secret but, as well as the 'plugs' breaking up the form and making it harder to understand, a variation in lightness to darkness creates a false sense of distance across an aircraft. "The darkness is what your eye is averaging," he explains. "With two colours together, as it goes further back, it transitions from dark to light."

The breaking up of forms and confusing attitudes through the use of highly contrasting angular geometric forms, pioneered by the 'Dazzle' schemes used on WW1 warships, was another camouflage system championed by an artist. During the same war, the most influential 'camoufleurs' (camouflage developers and appliers) were all artists, and Ferris follows a long tradition that proves the best person to create camouflage is someone who understands how to manipulate the perception of light – the artist. The camoufleur is essentially an inverted artist; the artist makes an aircraft's image more conspicuous, while the camoufleur does the opposite but the principles are the same.

Ferris retains an ability to simplify things to the most basic level. He understood, at the most fundamental level, how humans perceive aeroplanes and, once you know that, you can disrupt this perception.

DEFENCE

The art of camouflage



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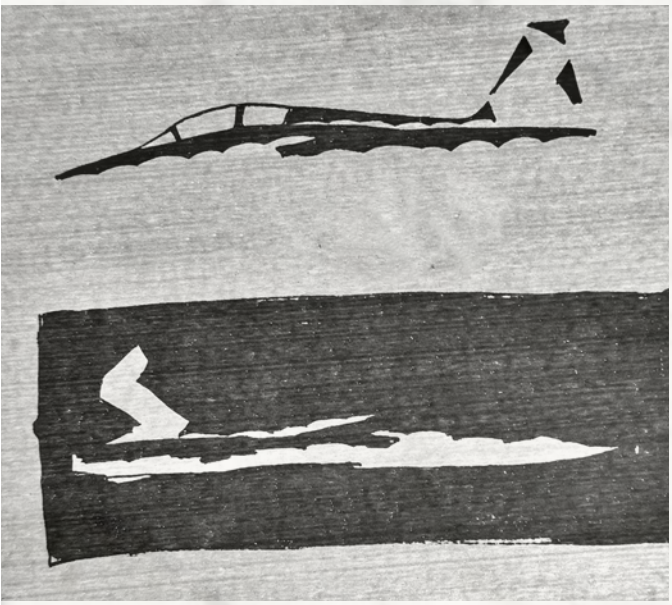

▲ A Canadian CF-18 Hornet demonstrates the false canopy to good effect.

▶ The moment of inspiration came to Ferris while flying aboard an F-4 Phantom.

◀ Longitudinal camouflage: the 'sausage' cut lengthwise.

All via Keith Ferris unless stated.

Opposite page, from top to bottom:

A Keith Ferris painting of an F-14 Tomcat in a Ferris Paint Scheme. The form of the vertical tails, a key feature of an aircraft's visual signature, is broken up. The darker or lighter sections will be more visible against different backgrounds, but neither, by itself, betrays the typical shape of an aircraft.

This diagram demonstrates how shape can be broken up against different backgrounds. No one 'plug' (colour block) reveals the aircraft's form by itself.

An F-15 wearing an 'averaging' scheme, somewhat reminiscent of WW1 battleships in their 'dazzle' camouflage.

Drawing a childish rendition of an aeroplane, a 'sausage' with a tail and wings, he demonstrates how we understand it: a fuselage, a tail and wings. Disrupt the ability to see these key shapes and you confuse the observer.

Ferris uses the term 'plug' to refer to a single colour section of a disruptive camouflage scheme. If any single plug reveals an aeroplane-like form, then the plugs need to be redesigned. "Cut the sausage lengthways, and you don't have a sausage anymore," he emphasises.

Many of his schemes disrupt a sense of symmetry, and the extended lighter or darker edges on some of his schemes distort scale, distance and wing angles. Ferris is amused by the attempts on some modern Russian aircraft to replicate his schemes, noting that they clearly do not understand the principles in question and he is tickled to see potential foes of the US floundering in ignorance.

High G in his 80s

In a lifetime of flying in the most exciting aircraft, Ferris lists his favourite aeroplane as the F-15 Eagle. Recalling one simulated dogfight flying an F-15E 16 years ago he describes hanging upside down, weightless, looking at the ocean and looking for his opponent. "Then I said to myself, 'why are you doing this?' I knocked off flying at 80 after flying for 50 years."

Ferris' remarkable life, from being one of the most successful aviation artists to changing the appearance of most combat aircraft in the world and flying in everything from the B-18 to the B-1B is a truly epic tale.

Every low-vis insignia on a US aircraft is a result of Ferris' work, as are the hi-vis schemes on training aircraft. The man behind the 'grey revolution,' Ferris is, without a doubt, the king of aerial camouflage.

Putting the 'air' into the Air Cadets

Developing airmanship, acquiring transferrable high-tech skills and creating the drone pilots of the future, RAF Air Cadets are now learning to fly UAVs. Wg Cdr **SCOTT BATEMAN** MBE RAFAC provides an insight into the programme and its aims.

Put simply, the primary mission of No 2 Flying Training School (FTS), is to put the 'Air' into the RAF Air Cadets.

The unit facilitates gliding for thousands of cadets every year through a national network of Voluntary Gliding Schools, as well as supporting the delivery of technical subjects through the newly formed regional Aerospace Ground Schools.

Back in early 2020, it was decided that the unit would explore adding remotely piloted systems to its portfolio and this is when I was asked to consider a return to uniform, after an 18-year hiatus, to assist the organisation with the project.

> "THIS WILL LIKELY MAKE THE ATC THE LARGEST DRONE OPERATOR IN TERMS OF QUALIFIED PILOTS IN THE UK, PERHAPS THE WORLD

Bold aspirations

The aspiration of the organisation was an extremely bold one where every individual in the organisation would be given the opportunity to complete a fundamental level of drone training using the UK Civil Aviation Authority (CAA), rather than the Military Aviation Authority (MAA) regulatory framework. This is appropriate given that the Air Cadets will not be doing any drone flying that has a military application. The rationale behind this unusual pathway for a cadet force was to provide tangible qualifications that can be used across the UK, setting a positive culture for safe and legal Remotely Piloted Aviation Systems (RPAS) use with our 35,000 aviation focused cadets and 10,000 adult volunteers.

Initially, the team developed a framework that took the available CAA qualifications and blended these into the RAF Air Cadets Progressive Training Syllabus. This allows a building block approach for cadets and adults to acquire the theoretical and practical skills required to safely and legally fly drones in the UK.

As part of this process, in 2023, the organisation became the first defence unit to hold a UK CAA Operating Approval in the specific category which potentially allows higher risk operations of aircraft up to 25kg in mass, noting that virtually all cadets would be training on drones up to 1kg in mass. Nonetheless, this important approval was the start of the journey towards becoming a CAA approved training and assessment entity for uncrewed systems.

Training the trainers

In early 2024, the unit was successful in securing three years of significant funding for its project from the Air Cadet Charity and this allowed the team to progress towards attaining our own training approval, while also starting to procure drones and train our staff to be instructors and coaches for the organisation.

This training, which started in December 2024, is currently being facilitated by a third party at the 2 FTS training facilities at RAF Little Rissington in Gloucestershire and RAF Syerston near Nottingham, while we work towards attaining our own training approvals. This is allowing us to build our instructor cadre and gain valuable experience delivering the CAA syllabus under the watchful eye of an already experienced provider.

With dozens of instructors trained to date, and with this training continuing at pace, we have now established the foundation which allows us to launch our first phase of the project at the National Air & Space Camp in August. This will see us train the entire organisation to the CAA Drone Model Aircraft Registration and Education System (DMARES) standard which is the gateway qualification for all drone flying in the UK and has at its core, the Drone Code. This will likely make the ATC the largest drone operator in terms of qualified pilots in the UK, perhaps the world.

Once qualified, cadets and adults will be allowed to start flying outdoors, under supervision, while also using our VR training systems to gain valuable practical flying training in a safe environment. The cadets can then progress onto the A2 Certificate of Competence (which is the next CAA qualification), allowing them to fly closer to people and in built-up areas. The final progression for the cadets will be to complete the Level 1 qualification on the newly released Remote Pilot Competency framework. This is the gateway certification to a new, four-level, suite of qualifications that allows remote pilots to work in higher-risk industry settings, military and emergency services roles. It is hoped that this tangible and transferable qualification will help enthuse and equip the cadets into considering aerospace or other roles as a career, while also having some fun.

Sovereign capability

Our main training drone is the DJI Air 3S, which is a great training platform and is at a price point that allows us, the organisation, to buy dozens to fly across its network, making this accessible to as many cadets as possible.

We also have some more capable specialist aircraft, such as the DJI Matrice 4T and the DJI Mavic 2 Enterprise, which allow us to bring an applied use element to keep trained pilots engaged and always aspiring to improve their skills.

▲ Clockwise from top left: With the UK government stating in its recently published *Strategic Defence Review* that it aims to expand in-school and community-based Cadet Forces by 30% by 2030 (with a long-term ambition to reach 250,000 cadets), the future of UK drone operations seems to be in safe hands.

Air Cadets at the 2024 Air & Space Camp drone courses got the chance to try out a simulator, fly small drones for real inside a cage and even construct Lego drones.

Instructors deliver the CAA syllabus with cadets having the option to continue their learning towards tangible qualifications.

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However, as these drones are all made overseas, they present some unique security challenges to our operation. These are mainly manageable, but where they are not, we have a small fleet of the Parrot Anafi USA thermal-equipped drones, which are not subject to the same restrictions.

The unit currently has over 80 drones and will continue to expand the fleet with new and donated aircraft as public funds become available or they are donated.

National RPAS Training Squadron

This summer, the project moves up a gear as we expand from building the capability for the regions to delivering, assuring and maintaining it. The unit will be established as the National RPAS Training Squadron, continuing to train and expand our adult instructor base, while also recruiting suitably qualified and experienced volunteers into newly established national roles as part of 2 FTS headquarters. These roles will be crucial to attaining and retaining our CAA training approval and delivering our aspiration to put the 'air' solidly back into the RAF Air Cadets.

Get involved

If you have an interest in drones, whether that be from an engineering, safety or operational perspective, and you could spare a few hours a week, then please consider joining the organisation and helping to inspire the next generation. Please contact Flight Commander Support, RPAS Training Squadron, at: **will.ainslie100@rafac.mod.gov.uk**

If you know of an organisation that is replacing its RPAS aircraft and looking for a good home to donate them to, or you would wish to sponsor some, please consider The Air Cadet Charity as a conduit to do this.

Indian Air Force

India vs Pakistan BVR Air Battle

In May, Indian and Pakistan air arms clashed in what has been described as the biggest ever beyond-visual-range (BVR) air battle over Kashmir. **ED HUNT** cuts through the fog of war to analyse the known facts.

Ministry of Defence of Pakistan

Although it was eventually overshadowed by Ukraine's audacious Spider's Web drone attack on Russian airfields (see page 12), the aerial engagement between India and Pakistan over Kashmir from 7-10 May should have been the defence news of the season.

Should the event be seen as a litmus test for contemporary aerial engagements or should it be regarded as interesting but influenced by the circumstances of that theatre's conditions? There is no short answer, nor a mutually agreed plot, but certain things are likely and the starting point for any analysis.

Flashpoint

◀ India ordered 36 Rafales directly from Dassault in 2015 to bolster its declining fighter fleet after plans to locally produce a larger number fell through.

The general background was an Indian strike in response to a terrorist attack that occurred in early May. This Indian effort targeted both claimed terrorist camps, as well as conventional Pakistani military installations, including air defence and air force installations. This indicates that the Indian effort was a political one, as well as a military one, implicitly blaming Pakistan for the terrorist attack through the targeting of national assets. The Pakistani Air Force (PAF) was certainly up and ready, and this is where the debate has become fierce.

While details still continue to emerge, there is general agreement that India undertook a stand-off strike against Pakistani targets from the Eastern side of the Line of Control. Air-launched BrahMos, together with French SCALP cruise missiles, seem to have been employed, taking advantage of the reduced vulnerability to Pakistani air defences. However, the wreckage of what appears to be a single Dassault Rafale and possibly a MiG-29/Su-30 have both been discovered within territory controlled by India.

Objective assessment

◀ Pakistan and China enjoy a close partnership on defence, with the former being an early export customer for the J-10.

As usual, the enthusiastic amateur brigade of smartphone users has both assisted and complicated any objective assessment of this. Parts of an Indian AF Dassault Rafale have been seen in pictures, as have elements of a Russian ejector seat. India announced that all aircrew are accounted for. Vague claims have been made that the PAF must have suffered losses, though nothing close to facts exist that might corroborate such a statement. India has suggested that operations lead to 'inevitable casualties', which does imply that losses were suffered. Pakistan claims to have destroyed five crewed and one uncrewed aircraft. If historical exaggeration of kill rates were maintained, Pakistani assertions of six victories versus two apparent wrecks would be exactly in keeping with the traditional 2:1 / 3:1 ratio of indicated to actual victories in air combat.

Beyond visual range

Much, if not all, of this combat was fought at extended ranges. India claims none of its aircraft penetrated far – if at all – into the disputed territory, and cites a lack of reciprocal Pakistani movement eastward as a reason that none of the latter supposed losses have been shown. While – again – this is a useful position for deniability, it does reflect the difficulties in evaluating engagement fought at long range. Indeed, if it transpires that all weapons used were of such a modern type, this could be the first air-land engagement fought at beyond-visual-range (BVR), long seen as the likely future of air combat.

While similar sentiments have existed since the 1960s, in reality, for political and operational reasons (including the need for visual identification), aircraft tend to be downed by weapons fired much closer to the target.

Both sides have invested heavily in such modern technology in recent years, although each operate a hodgepodge of aircraft. India's Rafale fleet, supported by its Dassault Mirage 2000s, is the leading edge, joined by the Sukhoi Su-30MKI with, to a lesser extent, the MiG-29 in operation for multiple roles.

Noticeable by its media absence during the conflict is the domestic Tejas light/medium fighter, which might have been expected to be a star. The Tejas is seen as part of Indian aerospace's new confidence and its capability to build wholly domestic platforms. However, up until now, the Rafale with a very capable sensor suite, plus the MBDA Meteor long-range air-to-air missile and SCALP air-to-ground munition has generally been considered to be India's gold standard. If these have been found wanting, it is worrying for New Delhi.

In contrast, Pakistan operates a mixed, but increasingly Chinese, collection of aircraft and weapons. Its older Lockheed Martin F-16s were not used in the combat (likely for political reasons) and the Chengdu J-10CE and its Chinese-developed PL-15 missile have been receiving most of the media attention. The latter is roughly comparable with the MBDA Meteor used by India. Both sides possess relatively modern Airborne Early Warning (AEW) and air-to-air refuelling (AAR) aircraft, although the degree to which these were used is unclear.

Initial evaluation

There has, understandably, been a rush to draw dramatic conclusions from what occurred. Figures of more than 100 aircraft involved (probably not simultaneously) have appeared but, as of early June, there is insufficient information to draw any deep evaluation.

The number of aircraft involved, range of engagement and the modernity of the platforms and weapons all make for several interesting aspects. One of the key factors is the command and control aspect, from top level down to sections of aircraft. Both sides had a lot of platforms airborne for what seems to have been around an hour.

That is a huge task in itself as attempts are made

Indian Air Force

to deconflict and manage formations of differing types, as well as manage different engagement priorities and weapons through co-ordination with ground HQs and AEW aircraft (and possibly tankers).

Added to this are the ground-based air defences on both sides, an element of multi-axis combat that has an unfortunate record for fratricide. Interestingly, there appears to have been no accidents of this nature, which is a strong endorsement of both sides' professionalism. There are also unconfirmed reports of Pakistan's Chinese HQ-9 (roughly a Patriot-ranged air defence system) being used, although this currently remains unclear.

Operations must have also placed an immense strain on network systems, primarily on the secure voice and data links. These operate directly between aircraft in the same formation, as well as automatically handing off and prioritising targets. In real time this is aided by advanced missiles, such as the Chinese-built PL-15 used by Pakistan. These weapons have a two-way data link so the missile can use the launch aircraft's radar information and the firing aircraft can also absorb what the missile is seeing. This technology is relatively new but becoming extremely common across many air forces, providing situational awareness at ranges never before available.

▲ India is a long-term operator of the MiG-29 family of Russian aircraft, with conflicting accounts of the type's involvement in the clashes.

Both the weapons themselves and their usage is relatively unprecedented. The PL-15 long-range, active radar guided missile has become something of a headline *cause célèbre*. Pakistan operates the export model, which might be somewhat downgraded from the Chinese version, but even open-source data suggests formidable capabilities. Of course, these can mostly be taken with a healthy pinch of salt as they are incredibly situation dependent – with both the launch aircraft speed and attitude being key to success.

Fitted with a small Active Electronically-Scanned Array (AESA) radar, a solid-fuel rocket motor (it is currently unclear if this is 'throttleable') and a second section for terminal phase thrust, the PL-15 claims a top speed of Mach 5 and a range of around 90 miles.

It was a PL-15, the wreckage of which has been discovered, that is credited with the downing of the Indian Rafale and MiG-29 aircraft. Beyond that, we are left largely with supposition. The use of active and passive electronic systems remains something of a mystery, but almost certainly occurred. The exact range at which launches and kills occurred also remains murky. The lack of data is down to operational security, some (possibly wounded) pride and more than a little fog of war. The latter, in particular, tends to hang around for quite some time.

▼ The Pakistan Aeronautical Complex and China's Chengdu Aircraft Industry Group have jointly developed the JF-17 Thunder, which has been manufactured in both countries.

Ministry of Defence of Pakistan

Via X

Ministry of Defence of Pakistan

Confident planning

So what can be pulled from all of this with any degree of certainty or utility?

Firstly, both sides felt sufficiently confident in their planning and systems to remain at range. This was also reflective of the complex political situation dominant in the area, but combat tends to rapidly move into shorter range as crews become focused on results over plans. More so when weapons and systems fail to function as advertised (targeting issues tend to increase rapidly with range) and simple mistakes lead to blundering encounters. Until greater detail becomes available, conclusions must remain tentative, but the Indian strike operation remained at a distance and the success of the PL-15 missiles (if correct) suggests a Pakistani willingness to trust long-range capability.

Secondly, Pakistan appears to have used its Saab 2000 Erieye AEW aircraft, probably adding their situational awareness benefits to the fighter and air defence components. It is unclear whether these can assist with targeting, but they would certainly be very useful in deconflicting the battle and providing Pakistani pilots with the confidence to launch their ranged weapons. Given that the cunning positioning of a fighter to launch a missile can have a huge impact on likely success, this might have been a key component that led to Indian pilots' failure to realise they were under threat until it was too late.

Finally, it is surprising that not more aircraft were claimed to have been destroyed. If approaching 100 platforms were really involved, under what appears to have been a fairly 'weapons-free' operational environment, the Indian loss of perhaps five fighters (or possibly only two) is galling but hardly catastrophic. By comparison, the USS *Harry S Truman* carrier strike group has lost more Super Hornets to non-combat reasons on its current cruise.

Are these relatively low Indian losses down to conservative engagement policy, the sheer difficulty of hitting modern fighters flown by capable crews or the fact that weapons tend to perform far below manufacturers' specifications?

The answer, as usual, is probably a mixture of the above but, for whatever reason, a major military operation might have been less costly than an average airshow season. This, like the dog that did not bark in the night, is also intriguing

▲ Left: Wreckage of a tail of an IAF Rafale indicated that that at least one Dassault-built fighter had been lost, especially when it would have been easy for New Delhi to publicly produce the same tail number the following morning if it had been fake.

Right: Saab 2000 Erieye AEW&C of the 3rd Squadron of the PAF.

> FOR WHATEVER REASON, A MAJOR MILITARY OPERATION MIGHT HAVE BEEN LESS COSTLY THAN AN AVERAGE AIRSHOW SEASON

More questions than answers

The questions about how the aircraft and weapons performed will be critical to the participants, manufacturers and other air arms using (or facing) the same systems.

Lessons regarding radar capabilities, comms, jamming, spoofing and how to tie this all together is priceless.

Did missile radars and data-links provide accurate and useful pictures, or did EW systems on the other side successfully fool these? What was the ratio of missiles fired by Pakistan for its five claimed kills? Under what circumstances vs recommended launch parameters were those missiles fired? How did ground vs air weapon deconfliction unfold? Did Pakistan obtain real-time data or voice information? Did India manage something similar?

Dassault is currently developing the F5 variant of the Rafale and could any lessons learned in Kashmir alter how that jet evolves?

Elsewhere, China's Chengdu and CAMA will be smugly satisfied about how its J-10 fighters and PL-15 missiles respectively fared in combat – but they should be wary of falling into the trap often built by success. The claims will possibly see increased interest in China as a weapons' supplier, particularly as the US seems intent on picking fights with traditional customers. Dassault is, undoubtedly, somewhat embarrassed but can always blame the Indians for poor employment and planning. If a MiG-29 (or Su-30) has also been lost, Russia's dismal reputation slides down a further notch.

Traditionally, these 'not-quite-war' encounters have tended to pit Soviet-developed fighters versus Western foe, possibly with support or ground defences thrown into the mix – but a French vs Chinese customer engagement, with a sprinkling of Russia and a Swedish AEW asset was something new.

The passionate politics make it difficult to piece together what actually happened, but the picture that can be built and then war-gamed will, undoubtedly, be written into the next round of Red Flags and equivalent.

The Ukrainian airfield drone strike is rightly occupying much brain power, but the encounter over Kashmir is a firm and clear reminder that the conventional, peer air battle has far from disappeared for the skies.

Keeping sustainability on the agenda

Via Farnborough International

Airbus

Via Farnborough International

Otto Aviation

The annual Sustainable Skies World Summit took place from 14 to 15 May at Farnborough, UK where government, industry and academia gathered to discuss progress in this area, as **JACK RICHARDSON** reports.

President Trump's return to the White House has created a whole host of uncertainties, one of which is the commitment to fighting climate change and reaching the target of net zero carbon emissions by 2050. Despite this, decarbonisation remains a major goal for the aerospace sector.

Since being established in 2022, the Sustainable Skies World Summit (SSWS) has grown from 169 registered attendees to more than 1,300 in 2025. This numerical growth is also reflected across the sector with over 1,000 aviation sustainability announcements made over the last month alone, according to Jonathon Counsell, Group Head of Sustainability at IAG, who gave an address on the opening day.

On that very day, the UK government announced £400,000 of funding to accelerate the production of Sustainable Aviation Fuel (SAF) in the country. Although the different varieties of SAF offer potentially exciting technologies to reduce carbon emissions from aviation, they suffer drawbacks, including high costs and unproven technology (See 'Scaling up SAF' *AEROSPACE* March 2025). It is concerns such as these that have led to a backlash against decarbonisation efforts in the US and Europe. However, Dr James Richardson, chief scientist for the UK's Climate Change Committee (CCC) defended decarbonisation efforts in a keynote address. "The transition is sweeping across sectors and your transition is coming soon," he said. He explained the CCC's role as an independent body, monitoring the UK and the devolved governments' efforts to address climate change, adding that after the next 'carbon budget' period of

Clockwise from top left:

RAeS CEO, David Edwards FRAeS (left) chairs a panel on how the sector can harness the necessary skills.

Companies all over the world are looking to deploy SAF but need financial certainty in order to do so.

Through the use of laminar flow technology, Otto Aviation hopes its new design will prove sustainable.

From SAF and alternative fuels to revolutionary flying machines, there was much to see and discuss at the Sustainable Skies World Summit.

2038-42 and into the 2043-50 timeframe, aviation, alongside shipping, will remain one of the most emitting sectors. "We have been very successful at decarbonising electricity, pushing coal out of the electricity supply," Dr Richardson said.

The need for certainty

As part of decarbonising the electricity grid, large-scale renewable energy has been rolled out using methods, such as solar and offshore wind power. The latter has had its funding levels guaranteed under 'contracts for difference,' where eligible companies are shielded from volatile electricity prices. As many sustainable aviation technologies remain in their infancy, a key issue is funding their development and upscaling.

On the second day, a panel discussing finance heard that the revenue certainty mechanisms provided for the renewables industry would prove invaluable for enabling long-term investment and research into SAF and other carbon reduction technology in aviation. Joshua Garton, Head of Financial and Investment Analysis at GSI, explained the importance of certainty to the banks, emphasising that: "once the sector scales to that commercial level, the markets develop and markets will then carry the weight of financing these projects."

Examples of innovation

For all of the work going into finding new fuels to decarbonise aviation, the most effective way to do this could, in fact, come from other methods, such as improved aerodynamics and management of contrails, particularly as there is a general reluctance to manage demand. One potential way forward is blended wing body (BWB) designs with the aircraft's engines, wings and fuselage all incorporated together. Several primes and start-ups are exploring these for civilian and military applications. On a panel considering the future of sustainable aviation, Diana Birkett Rakow, Senior Vice President Public Affairs and Sustainability at Alaska Airlines claimed that BWBs could cut emissions by up to 50%, even when using conventional jet fuel and existing components. To this end, the airline has invested in JetZero, one company trying to bring BWBs to market, which claims its design could not only benefit from SAF but also be future-proofed for hydrogen propulsion in the longer term.

Also present at the summit's 'Accelerator Hub' was Sora Aviation, a UK-based eVTOL firm which is looking to bring a six-motor (two on a forward wing, four on the rear wing) aircraft to market. Capable of carrying up to 30 people on routes such as airport transfers, the company presents its product as benefiting from economies of scale through carrying the equivalent passenger number of seven four-seat eVTOLs.

> "THE CONTINUED INTEREST IN DECARBONISING AVIATION WAS PLAIN TO SEE, DESPITE SCEPTICISM ABOUT HOW ACHIEVABLE MANY OF THE OBJECTIVES ARE

Another intriguing presentation came from US-based Otto Aviation which is developing a business jet which could later be scaled up to regional size, using laminar flow technology. NASA has called this the 'Holy Grail' of aerospace design because of its potential to cut drag and save fuel. The company uses computer modelling and advanced manufacturing techniques to produce a 'teardrop' shaped aircraft. The advantages of what the company calls this "revolutionary, gamechanging aircraft" are the ability to fly at 51,000ft, above most airliners, therefore eliminating the effects of contrails and burning 60% less fuel. The company claims that the significance of the latter is that, when using SAF, this use reduction will cancel out the so-called 'sustainability premium' which arises from SAF being more expensive.

Future talent

With many of these emerging technologies presenting promising routes to decarbonisation, the sector still faces a major challenge if these are to become a reality. Since the pandemic, the issue of how to ensure a sustainable aviation workforce has been at the forefront of the industry, with ways sought to secure a sustainable pipeline of labour.

Attending SSWS were a large number of students aged 13 to 17 who were given insights into potential careers in the industry and RAeS CEO, David Edwards FRAeS chaired a panel exploring common misconceptions around careers in aviation. One of the myths that the panel sought to debunk is the view that the majority of roles in the sector revolve directly around flight positions, such as pilots, with vital supporting positions, such as procurement and finance often overlooked.

On this theme, the former CEO of London Heathrow Airport, John Holland-Kaye once described the hub as "a city" with all the key jobs, such as human resources, that this entails. The panel also discussed ways to overcome barriers, such as using social media posts to explore 'a day in the life' of key aerospace employees, demonstrating the reality of roles that are available. A further discussion featured panellists who are early in their careers exploring how initiatives, such as 'career coaches,' can pass on experience from employee to employee.

Work to be done

As the summit drew to a close, the continued interest in decarbonising aviation was plain to see, despite scepticism about how achievable many of the objectives are. The number of challenges to be overcome remains daunting but, if obstacles such as finance and providing the right workforce can be surmounted, the potential for many of the ideas on display to become a reality exists, even if some of the deadlines may be met later than originally envisaged.

Casablanca Airport

Airbus

IATA

IATA – Custodians of the skies

The International Air Transport Association's AGM and World Air Transport Summit took place in India in June. **NEELAM MATHEWS** reports from New Delhi.

More than 1,700 global aviation leaders from the 350 International Air Transport Association (IATA) members gathered in New Delhi on 1-3 June for the organisation's 2025 AGM and World Air Transport Summit (WATS) .

The event was held at the right place at the right time, with India full of confidence and with an aviation industry that is both growing and undergoing rapid transformation.

The nation's Prime Minister, Narendra Modi, made history as the first head of government to address the IATA Summit in its 81-year existence, accentuating India's ambition to become a global aviation hub. His vision was echoed by Pieter Elbers, CEO of IndiGo and IATA Director General, who emphasised that India's aviation growth extends beyond any single airline saying: "This is more than just about IndiGo – it is about India's aviation story. It is a fitting time to show the world how India is redefining flight."

▲ Clockwise from top left: Morocco recently unveiled a $2.8bn airport expansion plan. New infrastructure, such as this, is vital to the development of the sector.

Incoming and outgoing IATA Director Generals, Pieter Elbers (left) and Willie Walsh get proceedings under way in New Delhi.

IndiGo received its first A320neo in 2019 and now operates 413 aircraft, with 885 more on order, including A350s.

Ambitious aspirations

India's plans include expanding airport infrastructure from its current 157 airports to 400 by 2047, a move aimed at strengthening its position in global aviation. Willie Walsh, outgoing Director General of IATA, expressed confidence in Modi's vision, stating India's ambitious aspirations will propel it into the ranks of leading aviation hubs.

The resilient aviation industry, having undergone a harrowing pre and post-pandemic period is now suffering the uncertainty over US

President Trump's tariffs. Supply chain disruptions also remain a pressing issue, with orders backlogged and relatively new aeroplanes in storage further complicating fleet expansion and shaking its sanity.

Yet the airline industry has managed to lift its head up through the clouds. IATA projected global airline profits to reach $36bn this year, with total industry revenue expected to rise to $979bn. Despite these impressive figures, Walsh pointed out that this translates to just $7.20 per passenger, highlighting the industry's razor-thin margins, which remain half of what most industries earn. Walsh noted: "Our profitability is not commensurate with the enormous value we create at the heart of a value chain supporting 3.9% of global GDP and providing jobs for 86.5m people."

Latin America's air travel surged 10.9% year-on-year, driven by liberalisation and infrastructure investments that have expanded connectivity and market access. Meanwhile, Africa and the Middle East struggle with $1.3bn in blocked airline funds due to government-imposed currency controls, economic instability and regulatory barriers that prevent airlines from repatriating revenues. Mozambique ($205m), Algeria ($178m), and Lebanon ($142m) are among the worst offenders and IATA has warned that these restrictions violate bilateral agreements, increase exchange rate risks, and threaten airline connectivity and profitability.

> AIRSPACE SHOULD NOT BE WEAPONISED IN TRADE DISPUTES

▼ IATA DG, Willie Walsh claimed that "narrow national interests" in Europe continue to appease air traffic controllers at the expense of travellers and warned of another summer of delays.

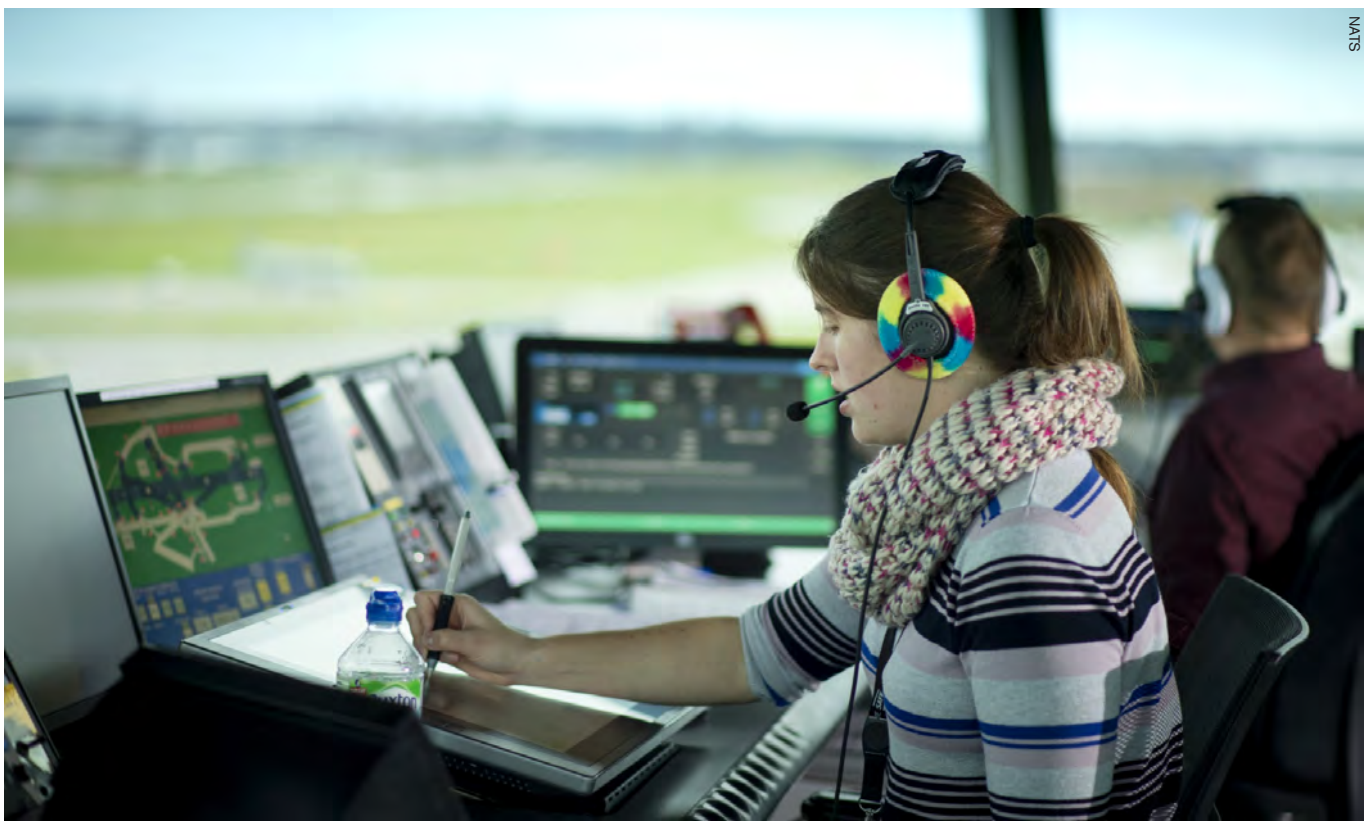
Trials and tribulations

While financial forecasts were optimistic, IATA warned of increasing cost pressures on airlines as the recovery from pandemic-related disruptions continues. Walsh did not hold back in his critique of government policies, particularly regarding aviation safety, geopolitical challenges, supply chain disruptions, airspace restrictions and regulatory inefficiencies. He emphasised that airspace should not be weaponised in trade disputes and warned that protectionist measures and excessive taxation could stifle industry growth.

An urgent need, said Walsh, was for the global adoption of digital ID systems, claiming passengers should be able to move through airport processes seamlessly without physical documents. He also emphasised AI-driven safety improvements, stating that "each new datapoint carries ever more potential to make flying safe."

Supply chain issues have had a substantial negative impact on airlines driving up leasing costs, increasing the average fleet age to 15 years (from 13 in 2015), cutting the fleet replacement rate to half the 5-6% of 2020, and reducing the efficiency of fleet.

The aircraft order backlog has surged to 17,000, with an implied wait time of 14 years, causing frustration among airlines. Walsh criticised


NATS

manufacturers, stating: "Aircraft makers continue to let their airline customers down. Indications that it could take until the end of the decade to fix them are off-the-chart unacceptable!"

In 2025, 1,692 aircraft are expected to be delivered. Although this would mark the highest level since 2018, it is almost 26% lower than estimates a year ago.

"In 2025, over one-fifth of aircraft deliveries are expected to be delayed," Subhas Menon, Director General of the Association of Asia Pacific Airlines (AAPA), told *AEROSPACE*. "Pandemic-induced supply chain disruptions remain unresolved and there's no clear path to any meaningful alleviation of these constraints."

"Trump's tariffs' tsunami has hit our industry hard," he continued. "Recent US tariffs have created uncertainty, leading to delayed aircraft deliveries and increased costs of components."

Engine problems and a shortage of spare parts exacerbate the situation and have caused record-high groundings of certain aircraft types. There are currently more than 1,100 aircraft younger than ten years in storage, constituting 3.8% of the total fleet (compared with 1.3% between 2015 and 2018). Nearly 70% of these grounded aircraft are equipped with Pratt & Whitney PW1000G engines.

Tim Clark, President of Emirates, also criticised OEMs for supply chain inefficiencies , saying: "I am pretty tired of seeing the hand-wringing about the supply chain. You [manufacturers] are the supply chain." Emirates has 205 Boeing 777X aircraft on order with deliveries now expected to begin between late 2026 and early 2027. He did acknowledge a renewed focus from Boeing's leadership to resolve 777X certification issues.

Meanwhile, Walsh called for greater clarity and consistency alluding to India's complex taxation system being a barrier to growth, arguing frequent tax changes add uncertainty for airlines. What is needed is a clearer understanding of how taxation rules apply," he emphasised.

Walsh did not spare Europe, however, calling it a "ground zero of an epidemic of ineffective consumer protection regulation". Europe faces rising operational costs due to stringent regulations. Under EU261, whether it is the power, IT or air traffic management that fails, when air travel is disrupted, airlines pay for passenger care and assistance."

Data drives safety

Taking place before the fatal Air India 787 disaster on 12 June, IATA highlighted safety efforts. In 2024, there were seven fatal airline accidents out of 40.6m flights, and 244 fatalities out of 4.8bn passengers. "Our aim, however, remains a future of zero accidents and zero fatalities. Data is critical to achieving that," said Walsh.

IATA's data initiatives on Global Aviation Data Management (GADM), Turbulence Aware, or its flagship IATA Operational Safety Audit (IOSA) and IATA's Safety Audit for Ground Operations (ISAGO) programmes, help it to evaluate safety insights. Last year GADM collected data covering

> "I AM PRETTY TIRED OF SEEING THE HAND-WRINGING ABOUT THE SUPPLY CHAIN. YOU [MANUFACTURERS] ARE THE SUPPLY CHAIN
>
> **Tim Clark**
> President of Emirates

◀ Prime Minister of India, Narendra Modi with Rahul Bhatia (Group MD of InterGlobe Enterprises) and Indigo CEO, Pieter Elbers during the summit.

> AIRCRAFT MAKERS CONTINUE TO LET THEIR AIRLINE CUSTOMERS DOWN. INDICATIONS THAT IT COULD TAKE UNTIL THE END OF THE DECADE TO FIX THEM ARE OFF-THE-CHART UNACCEPTABLE
>
> **Willie Walsh**
> Outgoing IATA Director General

over 8m flights, 50,0000 incidents and $11bn in maintenance costs.

Government inaction has held IATA back as around half of accident investigations (107 from 2018–2023) remain incomplete, delaying safety improvements. Walsh called it "dereliction of duty by governments as outlined in the Chicago Convention." (See 'Deafening silence', *AEROSPACE* October 2024).

Conflict zones

As conflict zones proliferate, an emerging issue is the sharing of information to keep civil aircraft safe. According to IATA, in the last 12 months, two civil aircraft were downed in the conflict zones of Kazakhstan (38 fatalities) and Sudan (five fatalities). Several airports with civilian aircraft on the ground were bombed during military operations and incidents of interference with navigation systems near conflicts rose sharply. Adoption of security management systems into the Chicago Convention's Annex 17 is a timely action, given that the ICAO Council recently pointed out the Russian Federation's involvement in the 2014 downing of Malaysia Airlines Flight MH17.

Nick Careen, Senior VP of Operations, Safety and Security, IATA said aviation carried over 5bn passengers on 40m flights in 2024, with 100,000 flights operating daily with an accident rate of 1.13 per million flights, which is lower than the five-year average of 1.25. Regional trends showed improvements in North America (1.20) and Asia-Pacific (1.04), while Africa's accident rate worsened to 10.59 per million flights.

The Ukraine-Russia conflict remains the primary cause of flight cancellations and rerouting in the EUROCONTROL network. On an average summer day with 35,000 flights, up to 2,000 (6% of total traffic) are cancelled due to closed Ukrainian airspace and sanctions restricting Russia-Europe flights. Additionally, 1,500 flights (4.5% of daily traffic) must be rerouted to avoid restricted airspace. These disruptions highlight the conflict's severe impact on aviation with longer, costlier routes, impacting fuel efficiency and emissions.

Heathrow under fire

"Despite ever increasing cost and tax challenges, the real cost of flying is 40% less than a decade ago," claimed Walsh, who added that "competitive market forces will continue that trend, provided we have sufficient capacity to meet demand, regulations that create value and processes that are efficient."

Infrastructure is a vital aspect of airport capacity and Walsh pointed out that "India, is opening new secondary airports in Delhi and Mumbai to cope with demand, Vietnam aims to have an airport within 100km of 97% of its population and Morocco is doubling its airport capacity by 2030. Dubai will [soon] begin the phased opening of the world's biggest airport while Singapore broke ground on a mega-terminal to open in the mid-2030s. Latin America's major hubs, such as Bogota, Buenos

▶ Air India is expanding its international footprint and upgrading its fleet with refitted Airbus A350s.

◀ In 2024, there were seven fatal airline accidents and 244 fatalities. There were also remarkable escapes, including the crew and passengers of JAL Flight 516 in Tokyo.

Aires, Lima, Mexico City, Panama City and São Paulo have either recently opened new facilities or have expansion projects under way and the US is pursuing a major air traffic management modernisation. In the UK, Heathrow Airport is buying a back-up phone, with a loud ringtone, for their CEO!"

He held Heathrow Airport to task for its lack of contingency planning, particularly its reliance on a single power source without an alternative, calling the recent fire in a substation a "clear planning failure."

He again asked why airlines should bear the cost of disrupted travellers when infrastructure fails.

"Europe is the exception"

"As always, the exception is Europe," Walsh continued, speaking of the "decades-old Single European Sky initiative," which promises cost, efficiency, safety and environmental benefits. "Yet, narrow national interests continue to appease air traffic controllers at the expense of travellers, likely leading to another summer of frustrating delays," he cautioned.

In the Netherlands, the government is "actively undermining competitiveness by reducing airport capacity under the guise of noise control," he added, pointing out that the plan to shrink Schiphol relied on a "balanced approach consultation that failed to consider airline-led noise reduction measures." Walsh warned this shortsighted policy could set a dangerous precedent if left unchallenged.

The sustainability challenge

Serious challenges persist for the aviation industry to achieve its net zero carbon emissions by 2050. Walsh stressed the need for policy support and investment for Sustainable Aviation Fuel (SAF) production, and IATA criticised Europe's SAF policies, arguing that mandates have unintentionally driven up costs, adding $1.7bn in compliance fees on top of market prices. Walsh urged governments to redirect the $1tn in annual fossil fuel subsidies toward SAF production and create integrated energy policies to support aviation's decarbonisation efforts and Marie Owens Thomsen, IATA's Senior VP of Sustainability and Chief Economist, added that "fragmented policies and v pricing behaviour can hinder SAF adoption."

IATA has already introduced the SAF Registry as a standardised system for tracking SAF purchases and emissions claims. The initiative aims to create a transparent, liquid SAF market, enabling airlines and corporations to co-finance SAF investments.

AAPA too is urging governments, fuel producers and airports to collaborate in accelerating SAF production. Singapore, for instance, home to Neste's large SAF refinery, will introduce a SAF levy in 2026, the first country to do so. Economy passengers will pay S$3 for Bangkok, S$6 for Tokyo and S$16 for London. The tax will fund mandatory SAF purchases, starting at 1% in 2026, rising to 3-5% by 2030.

> INDIA IS NO LONGER JUST AN EMERGING MARKET – IT IS A GLOBAL AVIATION POWERHOUSE
>
> **Pieter Elbers**
> CEO of IndiGo and incoming IATA Director General

▶ Indigo CEO and incoming IATA Director General, Pieter Elbers (left) with IATA Corporate Secretary & Acting General Counsel, Leslie MacIntosh, and outgoing Director General, Willie Walsh, during the AGM opening session.

Meanwhile, PTT Global Chemical has launched Thailand's first SAF production facility initially producing six million litres annually using used cooking oil.

The host's view

India's aviation sector supports 7.7m jobs and contributes $53.6bn to GDP. "India is no longer just an emerging market – it is a global aviation powerhouse," Pieter Elbers, CEO of IndiGo and IATA DG, told delegates. IndiGo currently operates 413 aircraft with 346 in service and 67 parked at last count. It also has 885 aircraft orders, making it India's fastest growing and largest airline, as well as the world's fifth largest. It is now strategically diversifying its fleet to expand its international presence with Elbers noting that the carrier would receive one aircraft per week for the next decade.

Marking a transition from a budget domestic model to a broader international footprint, IndiGo's entry into long-haul markets marks a strategic shift, while retaining its cost-efficient DNA. The airline has placed firm orders for 30 additional Airbus A350s, doubling its previous commitment to 60 aircraft with deliveries starting in 2027. Direct flights to ten new international destinations include London, Copenhagen and Athens with IndiGo's international network expanding from 41 to over 50 cities, and four Central Asian cities. The airline continues to optimise operations and expand MRO facilities to maintain cost efficiency.

At IATA, IndiGo announced partnerships with Delta, Air France-KLM and Virgin Atlantic to enhance connectivity between India, Europe and North America. The agreement includes expanded codeshare flights, operational synergies and Delta's planned return to India later with a direct Atlanta-Delhi service, pending approvals.

Meanwhile, Tata-owned Air India has completed the ambitious restructuring and merging of Air India, Air India Express, Vistara and AirAsia India – a process CEO, Campbell Wilson described as "the Everest of turnarounds." Presently, it has around 192 aircraft with 183 in service and a fleet of 400 aircraft expected by 2027. The full-service carrier is also expanding its international footprint and upgrading its fleet with refitted Airbus A350s. Orders for 570 new aircraft include Airbus A350s, Boeing 787s and 737MAXs. However, on 12 June it was thrown into crisis after a Boeing 787 Dreamliner with 242 on board crashed shortly after take-off from Ahmedabad, western India.

India's youngest airline, Akasa Air, has placed an order for 226 Boeing 737 MAX jets and already operates 29 of the jets. It has launched flights to Abu Dhabi and signed a codeshare agreement with Etihad Airways to strengthen Gulf sector connectivity.

As the industry navigates geopolitical tensions, economic uncertainties and environmental commitments, IATA's leadership remains focused on ensuring aviation's long-term viability. Elbers told *AEROSPACE* that the next IATA AGM, scheduled for Brazil in 2026, will likely revisit these pressing concerns while charting new strategies for global air transport.

BAE Systems

Air power into the future

In May, defence professionals, aerospace industry leaders and academics gathered in London for the RAeS FCAS Summit to discuss the fast-moving transformation affecting air and space power. **TIM ROBINSON** FRAeS reports on this landmark conference.

Tectonic shifts in geopolitics, China unveiling its mystery stealth aircraft, the constant innovation in drones in Ukraine, the US announcing its F-47 and then the imminent publication of the UK *Strategic Defence Review* (*SDR*) meant there was plenty for air and space power experts to discuss at the two-day FCAS Summit, held at RAeS HQ on 21-22 May. The conference brought together a wide range of experts from around the world to debate such topics as strengthening UK defence, international defence partnerships, European space capabilities, digitalisation, next-gen flight training, AI and cybersecurity, drones, technology demonstrators and more.

With two days of packed high-level presentations, this article then can only really provide a snapshot of the whole conference and themes. Let's take a look at just some of the highlights.

A 'genuinely transformative' SDR

Giving the keynote on the first day of the summit was one of the architects of the now published UK *SDR*, the Rt Hon Lord Robertson of Port Ellen who ahead of the publication said that it would be a "genuinely transformative" defence review. Robertson, a previous UK Defence Secretary and ex-NATO Secretary General contrasted the current geopolitical environment with a previous *SDR* he oversaw in 1998 when the UK had 10,000 troops committed just to Northern Ireland.

However, since then, successive defence reviews and the global war on terror since 2001 have seen the UK's high-end warfighting capability hollowed out – with the Russian invasion of Ukraine in early 2022 providing a wake-up call that the world had changed and rearmament is now critical – something that the *SDR* has now laid the foundations for. Robertson noted: "My contention is Ukraine is not the new war, it is the last war. We need to plan for the next war." With its emphasis on drones, cyber power and a 'Digital Targeting Web' to connect 'sensors to shooters', the now released *SDR* will seek to make good on Lord Robertson's suggestions – with promising the 'most significant defence reform and update in 150 years' from one of the authors.

Following this keynote, a panel, moderated by Sir Christoper Harper on 'Strengthening Britain's Defence'

Tim Robinson/RAeS

Tim Robinson/RAeS

Dassault

▲ Left: The conference heard progress updates from GCAP and Team Tempest technology demonstrators

Top: A stand-out presentation from WW2 veteran Flt Lt Colin Bell who was awarded an RAeS Fellowship.

Bottom: Eurofighter CEO, Jorge Tamarit Degenhardt explained how the Typhoon would be kept relevant until 2060.

Right: The Franco-German-Spanish FCAS sixth-gen fighter and weapon system was also discussed.

saw contributions from the Freeman Air and Space Institute's Dr Sophy Antrobus, Sir Brian Burridge and Sir Stuart Atha to address these vital questions. Harper, opening the panel, set the tone for the conference, observing that "we are already at war, but not in a traditional way" with the UK suffering seven million cyber-attacks per day from hostile actors.

While many would identify China as the 'pacing threat' in terms of developing next-generation military aerospace platforms, one suggestion from Antrobus was that just as the US Air Force Air University has a China Aerospace Studies Institute think-tank to study this potential adversary, the UK should also think about setting up an equivalent Russian aerospace studies think tank to keep track of, monitor and assess developments in Russian military aerospace.

Atha, meanwhile, observed that there were three lessons from the war in Ukraine – operational advantage/control of the air, what is a credible deterrent posture and thirdly the industrial dimension – especially innovating at pace.

Digital underpinning sixth-gen capabilities

Another theme to emerge strongly from the UK was the power of digitalisation – whether it is design, AI or the combat cloud – in powering these sixth-generation capabilities. As one senior MoD official noted of digital engineering: "In many ways I think it is the defining technology that makes sixth-generation different… the ability to change the capability, almost literally in flight, through an open system architecture that allows a capability to be upgraded far more easily, certified far more easily and separate safety-critical mission systems. All of those things are going to determine the speed of delivery, agility of the programme and, ultimately, the cost of the programme, as well as provide operational advantage."

This was reinforced by another presentation by Dr Arif Mustafa, Director Digital, RAF, who explained how the service now has its own in-house coders and software engineers. APPIVATE which comprises around 60 'lethal programmers,' according to Mustafa, is allowing the RAF to develop and code its own apps, as well as train up and nurture its own digital talent. In fact, he said some 10% of the RAF are now software or IT specialists – remarkably the same percentage as pilots. For sixth-generation platforms which will be dependent on a digital backbone in so many ways, the importance of these 'combat coders' is only likely to increase.

On the right track with sixth-generation fighters

Since the last FCAS Summit in May 2024, there have been several indications that the nebulous concept of a 'sixth-generation' combat air platform is now becoming far more defined with various countries' efforts coalescing around large, long-range aircraft – designed to be the piloted 'quarterback' of a larger future networked combat air system that involves drones, AI and space. Last year, for example, saw the unveiling of the newest UK/Italy/Japan GCAP configuration at the Farnborough Airshow – a giant delta wing combat aircraft that, in a recent RAF podcast, was described as having the range to fly transatlantic without needing air-to-air refuelling. In December the RAeS HQ itself was the venue for the signing of the industrial joint venture (now named Edgewing) by BAE Systems, Leonardo and Japan Aircraft Industrial Enhancement Co to deliver the GCAP programme. In December, China stunned the world with the reveal of the three-engined tailless delta J-36 (See *AEROSPACE*, March 2025) and another smaller tailless fighter. Finally, in late March, US President, Donald Trump announced that Boeing

was the winner of the NGAD competition – with its F-47 – again with what seems to be a large combat platform.

This convergence of design ideas, influenced by growing threats and lessons from Ukraine seems to indicate that sixth-generation fighters are now firming up. As one senior UK MoD official said at the FCAS Summit about GCAP: "I think we had a pretty strong sense of the threats two years ago, and we have a reasonably strong sense of the requirements and the solutions that would be needed to face that threat. But over the last couple of years, that has matured in a way that I'm surprised by. It's really struck me just how our understanding of what's necessary to meet that threat has come into real focus. It hasn't changed, but it is a lot better defined."

Aside from the technology itself, the culture and organisation of the GCAP enterprise is also breaking new ground said the official: "What's been going on in parallel with our industry partners is equally dramatic, which actually overcomes the sort of traditional issues around workshare and industrial competition with a joint venture approach and allows them to work properly together and jointly develop intellectual property to design on behalf of the three nations. That's incredibly important for pacing the programme, the reassurance of sovereignty, freedom of action and modification. It allows us to work in a way that other programmes in the past have struggled because of workshare and nationalisation."

Meanwhile, representatives from the Franco-German-Spanish FCAS future fighter programme provided a perspective on the other European sixth-generation combat aircraft programme under way – with a different industrial approach than the one being forged by GCAP – where public bickering over workshare has seen politics take centre stage. That said, Brigadier General Philippe Koffi, Chief NGWS/FCAS for France's DGA reported strong progress being made – with Phase 2 to be launched in mid-2026. Some 3,000 engineers are now working on this international project, with options for "the three most promising architectures" of the core New Generation Fighter (NGF) and remote carriers to be presented in September. A flying demonstrator is also due by the end of the decade.

Eurofighter – a sovereign European capability to 2060

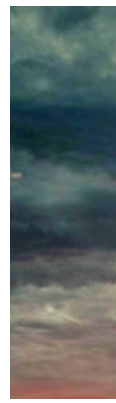
Providing a keynote speech on the second day was Eurofighter CEO, Jorge Tamarit Degenhardt, who stressed how this fighter, which he described as the "largest and most successful European defence collaborative programme" will not only be upgraded to bridge the gap between 4.5 gen fighters and 6th gen combat aircraft on the drawing board – but will also serve alongside these next-generation fighters to be part of the wider FCAS system until 2060. He said: "The Typhoon is an iconic combat aircraft but it must not be seen as a legacy platform." The midlife upgrade, or long-term evolution (LTE) will see new weapons and cockpit, and allow the Typhoon to pioneer capabilities, such as the combat cloud and loyal wingman drones – saying "Eurofighter will be the first combat platform to be involved in the new FCAS air power operational environment."

Degenhardt noted how geopolitical events were moving at 'lightspeed in the 'new world' and providing the impetus for follow-on sales from three of the four existing Eurofighter partners (Germany, Italy and Spain), as well as potential orders from new customers, such as Türkiye.

He added how the pan-European Eurofighter programme will help support the two European next-gen fighter efforts: "We are helping our customers to develop new technologies on a proven platform and benefit from common lessons. So every pound that is invested in the Eurofighter has an effect towards Euros spend on FCAS or GCAP."

Developing Europe's military space capabilities

Space is now an integral part of the military operations and is expected to be even more closely integrated in the future FCAS battlespace. However, pronouncements from the White House and threats to curtail intelligence sharing with Ukraine as a form of leverage have focused minds in European capitals as to the reliability of the US as a space partner and the need to develop sovereign capabilities. A panel comprising Dr Julia Balm from the Freeman Air and Space Institute, with Dr Raúl González Muñoz , University of Leicester, Dr Bleddyn Bowen, Durham University and Marco Aliberti, European Space Policy Institute attempted to provide answers to this question. While Bowen said "Europe as a whole… has a chance to build a comparative infrastructure" to the US and China, he admitted that UK military space had "too little money spread over too many projects,"



RAeS FCAS Summit 2025
Joint Q+A on The Future of Combat Air Capabilities
Moderator: Robert Courts - Former UK Aviation Minister
Maj Gen Jean-Luc Moritz - Future Combat Air System Director, French Air and Space Force
Brig Gen (Armament) Philippe Koffi - Head of NGWS/FCAS Programme, French
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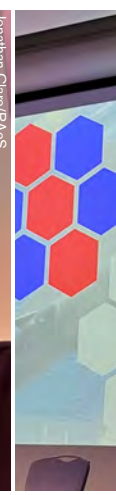


▼ Left: A panel saw UK GCAP and FCAS representatives outline their differing approaches to a future fighter.

Middle: Japanese Defence Attaché, Colonel Shingo Mizuiwa, JASDF, used the analogy of interlocking kumiko windows to explain the GCAP partnership.

Right: Sir Stuart Atha, BAE Systems provided high-level closing keynote.

▲ StormShroud is the first ACP (autonomous combat platform) to enter RAF service.

diluting the effort. Meanwhile, both Muñoz and Aliberti pointed to human spaceflight as an underappreciated resource for helping to generate interest and support in boosting European space capabilities.

The discussion also included the panel's thoughts on the news of the US 'Golden Dome' missile shield that was announced only a day previously. While Durham's Bowen was highly sceptical of its ability to counter an all-out ICBM strike, he did observe that the programme, which will rely on in-orbit sensors and effectors, could provide a secondary ASAT capability, as well as the $175bn funding stimulating R&D among defence firms eager to cash in on this project.

Sixth-generation training

Another insightful session at the summit looked at the training challenges for the force of tomorrow. Moderated by former aviation minister, Robert Courts KC, the panel included Gp Capt Ian Bews from 3FTS, RAF, Tim James, MD of Ascent and Tristan Crawford, CEO and founder of Aeralis. (See 'Aeralis assembles industry dream team', *AEROSPACE*, June 2025). With well-publicised issues in the fast jet pilot training system and even the SDR recommending the Hawk T.2 be replaced, Gp Capt Bews said that overall MFTS had 'closed the gap' between the training system and front-line pilots. However, he admitted there were still 'capacity problems.'

Meanwhile, Ascent's James outlined the two big challenges as he saw them – working around the slow MoD procurement cycle, as well as reluctance to share data – with modern training now relying on data to measure performance, optimise maintenance schedules and produce a standard 'product' in terms of a trained pilot.

Technology demonstrators

Wrapping up the panel sessions on the second day of the summit, and moderated by this author, was one on the three UK FCAS technology demonstrators – the as yet unnamed flying combat air demonstrator, the Excalibur airborne lab and the Orpheus advanced engine. All are national sovereign projects that feed into the tri-national GCAP programme.

Particularly noteworthy were comments from RAF Sqn Ldr 'William' – a requirements manager at the MoD, one of around 14 pilots that have already flown the Tempest demonstrator simulator and racked up 300+ hours testing in synthetic environments. Said William: "A really great example that's been used in detail on combat air demonstrator, has been the design of flight control laws, the level of pilot in the loop, interaction, flying qualities and handling qualities which is work we can do now."

He explained that, despite the size of the Tempest, advanced FBW would give it familiar, fighter-like handling. "It's very much a combat air type aircraft and it flies in that sort of way. Why that gets really interesting very quickly is that the sixth-generation platforms are considerably bigger. These are large aircraft; they're not small agile fighters anymore. Yet we're able to generate through the very clever use of control laws, essentially something that is still actually very familiar and gets the responses that you want. It's a big aircraft, it has inertia because that's just physics. That inertia has to be overcome by doing lots of clever things with the control surfaces."

Lessons from the past

Yet, despite the focus of the conference on 'future combat air capabilities,' advanced fighters, drones, AI and space, perhaps one of the most thought-provoking and powerful sessions was a fireside chat with 104-year old RAF Mosquito pilot, Flt Lt Colin Bell – who held the audience rapt with his crystal-clear recollections from WW2. As one of the last veterans from that devastating conflict, Bell's message was that defence needs to be taken seriously and given utmost priority as otherwise: "In the twinkling of an eye, you can lose everything. That is the importance of defence"– something that he had experienced first-hand in WW2. He added: "Spending on defence is the most important thing of all." Having flown the Mosquito, Spitfire and other types, he also picked the North American P-51 Mustang as an aircraft he wished he had flown – and pointed to the type's performance and its long range. With these new sixth-generation fighters also stressing long-range, it is thus notable that a WW2 pilot would also highlight this particular performance metric for its war-winning potential.

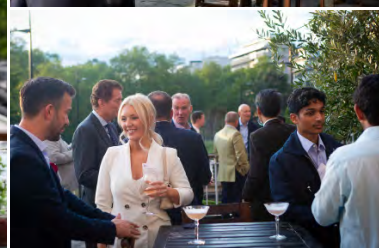
Now in its third year, the RAeS FCAS Summit has become a must-attend in the annual calendar for military and industry professionals. Furthermore, growing threats, geopolitical shifts, the increasing pace of technological change and a focus on rebuilding UK defences has made this year's summit even more topical than before.

RAeS FCAS Summit 2025
Sir Stuart Atha KBE CB DSO
Director of Training Strategy, BAE Systems
Closing Keynote
Tim Robinson/RAeS

RAES HQ, LONDON
TUESDAY 22 JULY 2025

ROYAL AERONAUTICAL SOCIETY

RAeS SUMMER RECEPTION 2025



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Diary

15 July 2025

Oxford Branch: Evolution of UK Army Aviation with Col Jim Peycke, Deputy Commander of 1 Aviation Brigade, Army Air Corps

Oxford Airport Auditorium, Kidlington, Oxford, OX5 1RA

A British Army Joint Terminal Attack Controller (JTAC), communicates with Wildcat helicopter aircrew before their landing during Exercise Spring Storm in Estonia in 2023. On this occasion, personnel from all three services of the UK Armed Forces were deployed to the former Eastern Bloc country to carry out exercises and operations. More than 1,500 troops deployed for the exercise, demonstrating the reinforcement of the UK-led NATO enhanced Forward Presence (eFP) Battlegroup to Brigade-sized strength. They operated alongside 14,000 personnel from 11 NATO countries, demonstrating the UK's commitment to the alliance. This annual multi-domain interoperability training now sees the UK commit an ever larger eFP commitment. British Army helicopters, such as the Wildcat, are essential to such operations and on 15 July, Col Jim Peycke, Deputy Commander of the Army Air Corps' 1 Aviation Brigade will discuss the evolution of army aviation at the Oxford Branch. Cpl Danny Houghton RLC/Crown Copyrigt

50 Message from RAeS

– From our President

"I am reminded of our Royal Charter, which states that one of our objectives is 'the general advancement of Aeronautical Art, Science and Engineering.'"

– From our Chief Executive Officer

"I know the entire Society's thoughts are with the families and friends of those lost and we hope that, as always, aviation will learn from the findings of the accident investigation to come."

52 Book Review
Eagle Days by Victoria Taylor

53 The National Aerospace Library's AI-powered research assistant
Research smarter with the new e-book research assistant.

54 The Lettice Curtis Collection
Documents and photographs from the legendary late aviatrix are now available at the NAL.

55 Elections
Newly elected RAeS Fellows, Members and Affiliates.

56 Diary
Upcoming Branch and HQ events.

56 From the Archives
The first pilot to exceed 3,000 hours in the Lockheed F-104 Starfighter.

57 New Member Spotlight
Senior Analysis Engineer at Safran Landing Systems UK, Alessia Ascione.

Message from RAeS

OUR PRESIDENT

Alisdair Wood

It was an honour to present Flt Lt Colin Bell (Retd) with his Fellowship certificate after his fireside chat at the Future Combat Air System Summit in May (see 'Air power into the future' page 44). At 104 years young, Colin described his exploits as a WW2 pathfinder pilot flying the de Havilland Mosquito on his many daring raids over heavily defended targets and the tactics used to avoid enemy contact.

The chat went beyond his flying experiences and Colin gave his thoughts on contemporary issues. As befitting the FCAS summit, Colin expressed his concerns that governments were not spending enough on defence – perhaps they heard him and the recent pledge to expand military spending is imperative at a time when deterrence through strength is so important. When asked whether he thought young people today would step up to the nation's need as they did in 1939, Colin quoted the 1933 Oxford Union debate in support of his belief that the young of today would defend the nation. This debate took place with the motion 'This House will under no circumstances fight for King and country'; the motion was carried by a convincing margin of 122 (275 for, 153 against). Later known as the Oxford Oath or Oxford Pledge, it was both controversial and emotional at the time. However, when the need arose they did fight for King and country. It was refreshing to witness Colin's confidence in our young people today.

In early June, the Shuttleworth Collection provided a wonderful backdrop for the Guild of Aviation Artists' annual exhibition. It was a pleasure to be there and present the Westland/Leonardo trophy for the best rotary-wing painting to Steven Winter for 'Merlin Incoming.' The quality on display was outstanding and acted as a reminder of the influence of art in the evolution of aviation, shaping not only how we perceive aircraft but also how they are designed and celebrated. The early depictions inspired both engineers and the public to believe in the possibility of human flight long before the Wright brothers' first powered flight in 1903. As aviation developed, art continued to influence design aesthetics and public engagement. Industrial designers, like Raymond Loewy, worked with aerospace companies to bring artistic elegance to cockpits and interiors.

In wartime, aviation art flourished through morale-boosting and communicative posters, such as the WW2 'Back Them Up' series. These images blended military identity with personal expression. In the height of the Cold War, art was used by both the US and the USSR to promote their space programmes as symbols of national strength and ideological superiority. Heroic images of cosmonauts and rockets were used to symbolise Communist progress and technological prowess. The NASA Art Program, launched in 1962, commissioned prominent US artists, among them Norman Rockwell and Robert Rauschenberg, to depict space missions, astronauts and the drama of exploration. The goal was to humanise the science and communicate NASA's vision to the public and gain acceptance for the huge sums spent on the programmes.

▲ At the Guild of Aviation Artists' annual exhibition, the President awarded the Westland/Leonardo trophy for the best rotary-wing artwork to Steven Winter for his painting, 'Merlin Incoming'.
Tim Robinson/RAeS

Aviation continues to inspire visual art, sculpture and multimedia installations. The intersection of art and aviation also appears in public displays – such as airshow performances and museum exhibitions – that blend technical mastery with aesthetic spectacle. There are generations of aerospace professionals and enthusiasts who became interested through the artwork of Roy Cross and Roy Huxley on Airfix and Matchbox model boxes.

I am reminded of our Royal Charter, which states that one of our objectives is 'the general advancement of Aeronautical Art, Science and Engineering.' (See 'The man who hid warplanes', page 26).

Each year, the Royal Academy of Engineering hosts the Professional Engineering Institutions' Presidents' Reception, an invaluable opportunity to compare notes and learn from each other. I attended the 2025 reception in June, where Royal Academy President, Sir John Lazar FREng provided an insightful address on the academy's three strategic outcomes: sustainable and innovative economy, technology improving lives, and an engineering community fit for the future.

While the academy is focused on engineering, we can all recognise the desirability of these outcomes and they can be expanded to satisfy the broader aerospace community. Lazar noted the 2024 Ipsos Veracity Index showed how engineering is the second most trusted profession but he asserted that we cannot rest on our laurels. Disasters, such as the Grenfell Tower fire, impacts negatively on public perception and maintaining our ethical basis requires effort.

On a positive note, the outcome of a 'community fit for the future' resonates well with the preparation of the President's Conference, 'People in Aerospace,' planned for early October.

> “
> I am reminded of our Royal Charter, which states that one of our objectives is 'the general advancement of Aeronautical Art, Science and Engineering'

OUR CHIEF EXECUTIVE OFFICER

David Edwards

For those of you who were able to attend the Society's Annual Banquet at the end of May, you would have been fortunate to have heard a masterclass in public speaking from Dr Brendan Nelson, Vice President of the Boeing Company and President, Boeing Global, explaining the company's history in our sector, intertwining it with the history of the Society's role in it. It was a reflective speech, set against a background of challenge to Boeing in recent times.

It was also very interesting to hear our President, Dr Alisdair Wood explain where his interest in flight safety came from, having had to take to his parachute from the prototype EH101 helicopter during flight trials back in 1995.

Against that background it was incredibly sad to hear of the loss, a short time later, of Air India Flight 171, a Boeing 787-8, immediately after take-off from Ahmedabad bound for London Gatwick. I know the entire Society's thoughts are with the families and friends of those lost and we hope that, as always, aviation will learn from the findings of the accident investigation to come.

I was pleased to hear a number of the Society's members providing their views to the news media in the days following the accident, the vast majority making it very clear that speculation did not help flight safety in any way. While the Society encourages Fellows and Members to identify their affiliation when commenting publicly, a reminder that speculating on live crash investigations can easily backfire and risks bringing the Society into disrepute. We would always advise caution

June brought the biennial Paris Air Show at Le Bourget. Obviously, being British, I have to comment on the weather: it was exceptionally hot but that also allowed for many conversations around the air-conditioned halls and chalets.

Getting to spend a couple of days at the show means I meet more members, Corporate Partners and the wider stakeholder community than I could normally achieve, so it is a great investment of my time. It is also useful to remind our France-based members about our branches in the country. The show was, perhaps unsurprisingly, focused on defence and I write this on the morning after USAF Northrop B-2 Spirit aircraft targeted Iranian nuclear facilities. However, Paris also saw a flying display by the Beta Technologies Alia CX300 electric aircraft showing the possibilities that lie ahead.

The *AEROSPACE* team provided a daily update from the show across our social media channels and an upcoming edition of the magazine will provide you with more news and behind-the-scenes information from the week in Paris. In the meantime, I urge you to check the *AEROSPACE* Insight daily blog and the videos from the show.

Ahead of Paris I spent the weekend with our Branches in Southampton. This year's Branch Conference was organised by the Solent Branch of the Society and it brought together representatives from the majority of the Society's Branches across the world. It was great to learn about the work being done at Heathrow in successfully attracting younger members, the work of the Solent Branch in partnership with the University of Southampton and to learn more about the impact of the Washington DC Branch's activities.

▲ Dr Brendan Nelson, Vice President of the Boeing Company and President, Boeing Global, addresses diners at the RAeS Annual Banquet at the end of May. Alex Bielinski/RAeS

As always though, the main benefit for me is the opportunity to meet with some of the Society's active volunteers who support our Branch activities – they are a passionate and dedicated cohort who ensure that fellowship and learning continue to be offered in the Society's name globally all year round.

As the Society enters the summer, we see the end of most Branches' programmes before they begin again in the early autumn. However, for the Society's staff and the volunteers who support our outreach work, the summer marks the busiest point in our calendar.

We have already been at the Big Bang Fair at the NEC in Birmingham, which is the largest STEM careers fair in the country, and we are building up our presence at the Royal International Air Tattoo in July. Last year we interacted with somewhere around 80,000 young people at RIAT and I'm still debating whether we need to wear hearing protection for the aircraft display or for the kids inside the TechnoZone! Either way, it is a summer of inspiration for the Society and we will be there, as well as at a number of other outreach events across the UK.

I know our Branches and Divisions all around the world are doing the same so here's to a busy summer.

Finally, as these words are written, we are just about to begin the Society's Sustainability Week, looking at sustainability in the widest sense across all of our stakeholder community (and the Society itself) – look out for more of the impact that this has had in next month's *AEROSPACE* magazine.

> “I know the entire Society's thoughts are with the families and friends of those lost and we hope that, as always, aviation will learn from the findings of the accident investigation to come

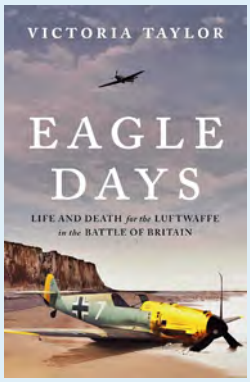
Book Reviews

THE LUFTWAFFE'S BATTLE

Eagle Days: Life and Death for the Luftwaffe in the Battle of Britain

Victoria Taylor

2025, Head of Zeus Ltd, London, 415pp. £25.00 hardback and £17.50 e-book.



Numerous books and articles have been written about the Battle of Britain and the subject appears in many works looking at related subjects but Dr Taylor's work is truly unique.

In her introduction, Dr Taylor says of the battle: "The true objectives, operational culture and battle cohesion of the Luftwaffe in the campaign cannot be fully comprehended on a military level if its combat mentality, experiences and morale on a more personal level are not also understood." She does this through quotations from contemporary material, such as letters, reports, intercepted conversations between prisoners and newspaper stories to produce an extremely interesting narrative, clearly based on extensive research in many archives, some of which I would never have thought of using.

She has a very distinct way of looking at the Luftwaffe and its men, which is quite different to earlier works on the Battle of Britain. She notes how many post-war German writers attempt to describe the campaign as a struggle between 'knights-of-the-air' but she also shows the impact of Nazi beliefs upon the contemporary German attitude. Dr Taylor also shows how the beliefs of officers and their men influenced operational decisions or was reflected by those decisions.

Sometimes there are surprising revelations, such as Göring's famous remark that the German people could call him 'Meier'. Like most people I thought this was a Jewish name but Dr Taylor points out it is a common German name. She also provides considerable insight into the personnel side of Luftwaffe training, and operational and training casualties, as well as the rarely described factor of combat fatigue.

The influence of German feelings even extended to the making of the *Battle of Britain* film, where Dr Taylor points out it was at the insistence of Adolf Galland that a sequence involving a British fighter pilot being machine-gunned while descending in his parachute was scrapped. Yet in describing this, Dr Taylor appears unaware that Dowding in his Despatches regarded this as perfectly acceptable, which is also how he felt about attacking air-sea rescue aircraft.

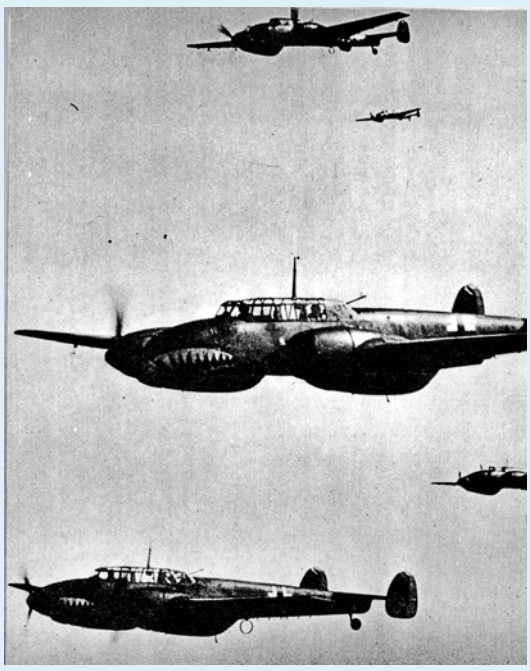
While Fighter Command obviously is the key to the Battle of Britain. it should not be forgotten that Bomber Command's attacks on the assembly of amphibious vessels also had an important role. It is disappointing, therefore, that the German reaction to these attacks is one of the few areas neglected in this account.

Dr Taylor is also apparently unaware that decoded Enigma material shows Luftwaffe attention was focused upon preparing a massive victory fly-past over Paris, even in early August.

The reader may well feel this extremely well-researched book spends too much time focusing on personnel issues and neglects the operational aspects of the Battle of Britain but this reviewer disagrees. There are numerous works, for example those of the late Alfred Price, looking at the operational decisions in great detail, as well as the important relationships between the Luftwaffe leaders. Indeed, Dr Taylor provides much interesting material on Göring's relations with Luftwaffe personnel, some of which I read here for the first time. The lack of operational detail is, therefore, not a reason for leaving this book on the shelf.

On the contrary, I believe Dr Taylor's approach makes this a must-have book for anyone studying the Battle of Britain and should be read simultaneously with operational histories to provide further understanding of German thought and intentions. Of course, this does mean a similar study on Fighter Command's crews should also now be available for the reader.

Edward Hooton



◀ A formation of Messerschmitt Bf110s from the Haifisch-Gruppe ('Shark Group' of Zerstörergeschwader 76 (ZG76) around the time of the Battle of Britain.
NAL/RAeS

NAL'S AI-POWERED RESEARCH ASSISTANT

The National Aerospace Library's e-book collection just got smarter. Society members already have access to a wide-ranging collection of e-books, covering topics in aviation and aerospace – ideal for supporting your professional development, research and studies.

Now, the NAL's e-book library features an AI-powered e-book research assistant to make your research even more efficient and insightful. The assistant is built directly into the e-book library platform to help professionals, researchers and students:

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- Deepen understanding of key concepts.
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How it works

The AI assistant displays helpful insights in a panel on the side of the screen, offering features, such as:

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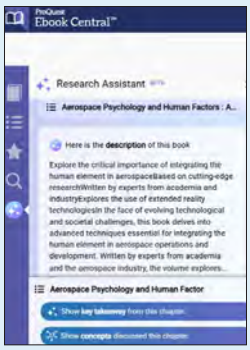
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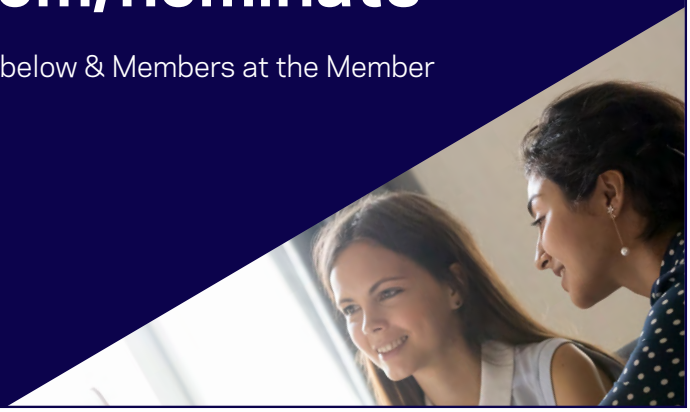
Did you know you can nominate your peers and colleagues for membership?* Your recommendation will allow them to benefit from a streamlined application process.

Nominate here:

www.aerosociety.com/nominate

*Fellows can nominate at the Fellow grade and below & Members at the Member grade and below.



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membership@aerosociety.com

Society News

THE LETTICE CURTIS COLLECTION

The National Aerospace Library (NAL) would like to highlight the now accessible collection of British pioneering aviatrix, Eleanor 'Lettice' Curtis.

Lettice Curtis' extraordinary contributions during WW2 and beyond cemented her legacy as one of the trailblazing female aviators of her time.

She was born in 1915 and developed a fascination with flying in an era when aviation was still a largely male-dominated field. After studying mathematics at the University of Oxford, she set her mind on a career in aviation after a conversation with a pilot she saw landing at Haldon. For Curtis, this appeared 'an active occupation infinitely preferable to sitting in an office.'

Taking her B licence medical in front of the RAF's Central Medical Board, its notes described her as 'far too nervous to ever become a pilot'. However, after gaining a pass from the board, she was undeterred and continued her plan, with her first flight taking place on 16 June 1937 in de Havilland Cirrus Moth G-EBZC.

Curtis' B licence was dated 1 April 1938 and in May she got her first flying job with Charles Lloyd, who owned CL Air Surveys, to photograph areas of England for revision of the Ordnance Survey 25in maps. Curtis' photo album – now at the NAL – presents photographs of her time at CL Air Surveys with images of her, her colleagues, the equipment used and articles of their work.

With WW2 under way, the Air Transport Auxiliary (ATA) was formed, an organisation that would prove critical to the war effort through ferrying aircraft across Britain. With the war progressing, the need for more ATA pilots became urgent and, in June 1940, Curtis received a letter from Pauline Gower, head of the ATA Women's Ferry Pool at Hatfield inviting her to join the group.

The correspondence presenting the decisions surrounding the formation of the ATA and inclusion of female pilots are accessible from the NAL's archive, alongside ATA personnel papers and photographs and information regarding White Waltham Aerodrome and its ATA pilots.

During her time in the ATA, Curtis became one of the first women to fly the most complex and powerful aircraft, including Spitfires and Mosquitos. In 1942 she was awarded Class 5 (four-engine conversion) status by her commanding officer, Frank Francis. This made Curtis the first woman to be trained on four-engined bombers, an achievement even more groundbreaking as women in aviation at that time often faced scepticism and outright discrimination. By the end of the war and, with the ATA ceasing activity at the end of November 1945, Curtis had flown more than 400 heavy bombers, 150 Mosquitos and hundreds of Hurricanes and Spitfires. Her achievements, despite popular scepticism towards women within aviation, had set a precedent that proved female pilots were just as capable as their male counterparts.

▲ A portrait of legendary pilot, Lettice Curtis during her time with the WW2 ATA.

After the war, Curtis remained passionate about aviation, joining the Ministry of Civil Aviation (MCA) in February 1946. In 1948, flying Supermarine Spitfire PR.XI PL983 (which is still airworthy and based at Duxford), Curtis achieved the British women's record of the fastest time by an aeroplane (F.A.I Class 'C') over a 100km closed circuit course. The certificate, outlining her performance times, is now accessible at the NAL.

Her inspiring career continued, including ferrying an Avro Lincoln RE258 to Australia and a Britten-Norman Islander to India. The details of her routes and notes of these journeys form part of the collection and give us an insight into her career ferrying aircraft.

▶ Celebrating the award of her PPL(H) licence in October 1992 at the age of 77.

▶ Members of the ATA's No.5 Ferry Pool in May 1941. L-R: Miss Connie Leathart, Mrs Alan Butler, Miss Margaret Cunnison, Miss Pauline Gower, Miss Jackie Sorour, Mrs Honour Salmon, Mrs Ann Douglas, Miss Anna Leska, Miss Barbara Wotulanis, Mrs Winifred Crossley, Miss Lettice Curtis, Mrs Patricia Beverley, Miss Audrey MacMillan, Miss Rosemary Rees and The Hon Mrs K Farrer.

All images: NAL/RAeS

Even in later life, her achievements continued and, in 1992, she became the oldest British woman to achieve her Helicopter Pilot's Licence at the age of 77. Curtis also proved her literary talent as she began to write extensively on aviation topics, publishing a number of articles and books which, alongside her autobiography, are all available within our NAL collection.

Lettice Curtis passed away in 2014 at the age of 99. However she leaves behind a legacy that continues to inspire women in aviation and beyond. Her publications, alongside her collection of papers presenting her life and career from her education, to her time in the ATA, her post-war career, research and photographic material are all available to view at the National Aerospace Library.

Georgina Townsend

Elections

FELLOWS

Andrew Arnold
James Bell
Cameron Bodey
Philip Carter
Roger Day
Ashoke De
Thomas Dunn
David Gerada
Alan Gillespie
Erik Janke
Mark Peter Jones
Susmita Naskar
Muneeb Rashid
Julia Rothman
James Scott
Klaus Sievers
Philip Smallwood
Lincoln Taylor
Chris Van Schalkwyk
Michael Wiggins
Christopher Williams
Steven Wooding

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WITH REGRET

The Royal Aeronautical Society announces, with regret, the death of the following members:

Herbert Brocklesby FRAeS 88
Raymond Gearing FRAeS 94
Geoffrey Mark Le Good MRAeS 62
Dr Anton Maneschijn FRAeS 67
Capt Desmond Penrose FRAeS 95

KING'S BIRTHDAY HONOURS 2025

The Royal Aeronautical Society would like to congratulate the followng members who have been named in The King's Birthday Honours List 2025:

Paul Livingston FRAeS: Chief Executive, Lockheed Martin UK, appointed a CBE for services to the defence industry.

Will Whitehorn FRAeS: Former UKspace President, appointed an OBE for services to the aerospace industry.

Rachel Gardner-Poole FRAeS: Board Adviser, Astroscale, appointed an OBE for services to aviation.

Dr Peter James Musgrove MRAeS: appointed an OBE for services to renewable energy.

Diary

EVENTS

1 July
RAeS Air Law Specialist Group Seminar: Navigating Artificial Intelligence in Aviation – Regulatory, Liability and Insurance Considerations
Offices of DAC Beachcroft, 25 Walbrook, London EC4N 8AF

1 July
AeroChallenge 2025: Build Challenge
Open to students, apprentices and recent graduates.
Deadline to submit entries to the AeroChallenge Build Challenge.

2 July
North Wiltshire Branch: History of the RAF's Hercules Fleet
Wg Cdr Paul Shepherd (Retd)
The Deanery CE Academy, Swindon SN1 7DA

3 July
Munich Branch: Women in Aerospace
Speaker TBC
Boltzmannstr, 15(5508), 2.Obergeschoß, 85748 Garching b München, Germany

8 July
RAeS Online Webinar: Design, Build, Fly - Lessons from Race2Space
David Chinn and Alistair John
Online Event

15 July
Oxford Branch: Evolution of UK Army Aviation
Col Jim Peycke, Deputy Commander of 1 Aviation Brigade, AAC
Oxford Airport Auditorium, Kidlington, Oxford OX5 1RA

16-17 July
RAeS supported event: The Chief of the Air Staff's Global Air and Space Chiefs' Conference
IET, 1 Savoy Place, London WC2R 0BL

16-17 July
RAeS supported event: UK Space Conference 2025
Manchester Central, Windmill Street, Manchester M2 3GX

18 July
AeroChallenge 2025: Virtual Live Quiz
Open to students, apprentices and recent graduates.
Online Event

22 July
RAeS Summer Reception 2025
Royal Aeronautical Society HQ, No.4 Hamilton Place, London W1J 7BQ

3 September
North Wiltshire Branch: Building Blue Danube – Britain's first atomic bomb
Jonathan Aylen - Senior Visiting Research Fellow, University of Manchester
The Deanery CE Academy, Swindon SN1 7DA

11 September
Bedford Branch: Outside of the box – helicopter operations
Jack Harding, Helicopter Pilot, Northern Helicopter GmbH
ARA Sports and Social Club, 2000 Manton Ln, Manton Industrial Estate, Bedfordshire MK41 7PF (and online)

17 September
Preston Branch: Racing gliders
Venue TBC

18 September
RAeS Amy Johnson Named Lecture 2025: MRO Through the Ages and Beyond: Safeguarding Airpower from Propellers to AI Wings
Smriti Hamal, Senior Air Safety Consultant at AtkinsRéalis
Royal Aeronautical Society HQ, No.4 Hamilton Place, London W1J 7BQ

25 September
RAeS Lecture: Airlines in South America 1920-1942 - The German influence.
Captain Dacre Watson
Royal Aeronautical Society HQ, No.4 Hamilton Place, London W1J 7BQ

6 October
RAeS Mental Health Awareness Day
Royal Aeronautical Society HQ, No.4 Hamilton Place, London W1J 7BQ

For further information and booking, visit **aerosociety.com/events-calendar/**

FROM THE ARCHIVE

While the Lockheed F-104 Starfighter was notoriously difficult to fly and earned the perhaps-unfounded reputation as the 'widow maker' while in service with the German Luftwaffe, some pilots did amass a large number of hours on the type. Col Joseph Robert Nevers (illustrated) was the first pilot to surpass 3,000 hours on the high-performance fighter and eventually finished his 35-year USAF career with a total of 4,885 Starfighter flying hours – a feat only exceeded by one other person in USAF history. These formed a significant part of his total 7,700 flying hours, which included tours on the North American F-86 Sabre and F-100 Super Sabre. Nevers flew F-104 combat missions in the Vietnam War and returned to that combat theatre later on as a Deputy Base Commander of a Special Operations Wing operating in Thailand. Other key assignments included: Director of F-104 operations at Luke AFB, Arizona; Deputy Base Commander at Homestead AFB, Florida and Commander of the 354th Combat Support Group at Myrtle Beach AFB. He was also awarded the Legion of Merit, Bronze Star, two Distinguished Flying Crosses and five Air Medals and was one of the earliest members of the Experimental Aircraft Association. He passed away, aged 89, in 2019. RAeS/NAL

For daily historic aviation content see the 'On This Day in Aviation History' feature on the Society's Facebook and LinkedIn pages.

New Member Spotlight

ALESSIA ASCIONE

Name: Alessia Ascione

Grade: Member

Age: 36

Location: Cheltenham, Gloucestershire

Job title: Senior Analysis Engineer, Safran Landing Systems UK

What inspired you into aerospace? From a young age, I was fascinated by aviation. I would spend hours on our apartment balcony, binoculars in hand, watching aircraft at the nearby airport. That early sense of wonder sparked my decision to study Aerospace Engineering. After completing my BEng degree, I undertook an internship in the R&D department of a major engineering company operating in the energy sector. Although not in aerospace, working alongside experienced engineers sharpened my technical and analytical skills. Eager to align my career with my passion, I pursued a master's degree, followed by a PhD in Aerospace Engineering, focusing on advanced research and innovation. This path has prepared me to contribute meaningfully to the aerospace sector and to drive technological advancements in aviation.

What's the best thing about your current role? The best part of my current role as a Senior Stress Engineer and newly appointed Project Leader within the R&T team is the unique blend of technical and leadership responsibilities. I continue to perform advanced stress and fatigue analysis, particularly focusing on the use of composite materials for landing gear applications. At the same time, leading a project allows me to shape innovation strategies, manage cross-functional collaboration and drive technical excellence. I enjoy the challenge of balancing hands-on technical work with the broader vision and co-ordination needed to deliver future-ready, sustainable solutions for the aerospace sector.

What made you join the RAeS? To be part of a community committed to advancing excellence in aerospace and to support my goal of becoming a Chartered Engineer. The Society offers unparalleled resources for professional development, networking and staying at the forefront of industry innovation. Its focus on high professional standards aligns perfectly with my aspirations. Being a member connects me with like-minded professionals, provides access to thought leadership and supports my continuous growth. I believe that Chartership is not only a recognition of expertise but also a commitment to lifelong learning and contributing to the future of aerospace.

What do you hope to get out of your registration with the RAeS? I hope to broaden my technical knowledge and professional influence. Achieving Chartered Engineer status is a key objective as it represents a formal recognition of my skills, leadership and commitment to the profession. I am excited to engage in Continuing Professional Development activities, attend technical lectures and contribute to the Society's knowledge-sharing initiatives. Beyond personal growth, I look forward to giving back to the community by mentoring young engineers and promoting diversity and inclusion within the industry. The RAeS offers a vital platform to grow, contribute and lead.

What three items would you take with you to the space station? I would bring a yoga mat, a notebook to document thoughts and experiences, and a camera to capture the unique beauty of Earth and life in orbit. Maintaining physical and mental wellbeing would be essential in microgravity, while journaling would provide a space for reflection during such a life-changing journey. Photography would allow me to share these incredible moments, inspiring others about the importance of exploration and our place in the Universe.

Who is your biggest inspiration? My father has been my greatest inspiration. He encouraged my curiosity and critical thinking from an early age, nurturing my passion for engineering and aviation. His belief in my abilities gave me the confidence to pursue a challenging academic and professional path. Professionally, my PhD supervisor also played a pivotal role, teaching me the importance of resilience, kindness and clear communication in high-pressure environments. Both have shaped my values and professional philosophy, inspiring me to combine technical excellence with compassion, perseverance and a commitment to helping others succeed in their own aerospace journeys.

Piece of advice for someone looking to enter your field? Stay curious, adaptable and embrace continuous learning. Aerospace is an exciting and rapidly evolving field where challenges are complex, and solutions require both creativity and technical rigour. Build a strong foundation in engineering principles but also develop skills in communication, collaboration and leadership. Seek out mentors, ask questions without hesitation and view every setback as a learning opportunity. Getting involved with professional organisations, like the RAeS, can open doors to knowledge, networks and career development. Most importantly, stay passionate – your enthusiasm will fuel your resilience and make your journey all the more rewarding.

The Last Word

COMMENTARY FROM
Professor Keith Hayward
FRAeS

Space vandalism

Imagine the scene. The year is 1961 and we are on the verge of the race to the Moon. The newly forged NASA is about to see a huge increase in its space-related budget.

Now, fast forward to 2025 and NASA's latest budget has, when inflation-adjusted, been cut to the same level. At $18.8bn it is in monetary terms the same as it was in 2015. Human space will take a hit, but the real effects will be felt on scientific missions with the list of threatened projects including:

- The Mars return mission, already doubtful on cost grounds and one of the most expensive small buckets of soil imaginable.
- Two Venus targeted missions, the first for NASA since 1989.
- The $3.9bn Nancy Grace Roman Space Telescope to succeed the Webb and Hubble telescopes.

The Grace mission might just survive if money already spent is not to be written off, but wave goodbye to ESA's contribution to the Mars robotic programme. The new focus, if not already implicit in much of recent policy, will be the high-profile crewed missions into deep space, especially to Mars. The Isaac Asimov sci-fi fantasies of Messrs Musk and Bezos are all over this shift in resources. Musk's rockets and capsules (if they finally work) will be at the heart of the mission. Even if its leader is dropped from the president's court, SpaceX remains front and centre to the enterprise.

Moonshine

Then there is the chaotic state of the various Moon-related programmes currently managed and funded by NASA. The Artemis trio of Space Launch System (SLS), Orion capsule and Moon orbiting Lunar Gateway are on life support, along with another tranche of ESA work.

SpaceX and Blue Origin might provide an alternative to SLS with a limping attempt to land a second round of American moonwalkers but there are lots of unknowns and untested details with items, such as in-orbit refuelling and the critical lander system still on the drawing board.

The hovering threat of a red Chinese flag might add a goad to progress, and there must be a bet to be made on a Chinese landing before 2028. However, an overhasty commitment to launch contains its own risks and another Apollo 1 or repeat of either Shuttle disasters would be too awful to contemplate.

Dubious value

I am not a great fan of the human space programme. Although SpaceX has reduced some of its upfront costs, I have yet to see a satisfactory cost-benefit study that does not include the scientific benefits of supporting humans in space. However, to cut genuinely valuable, if not dollar measurable science missions, at the same time is a true act of egregious vandalism.

Permanent settlements on the Moon or Mars will be hideously expensive to sustain and, unless one is mainlining the importance of human exploration for its own sake, with very little return to the Earthbound.

The 'saving of humanity' argument has no resonance in this column. More important would be to direct resources to the hugely valuable asset of space-based applications in helping to stave off climate change or at least to mitigate its effects.

Aeronautical vandalism

Of course, looking across to the first 'A' in NASA, Aeronautics, any mention of 'green' aviation or its space-based dimensions faces a White House led witch-hunt based on climate change denial to eradicate any investment in environmentally related activity.

I will be returning to this piece of idiocy later but under any other regime the logic underlying the entire approach to NASA budget setting would set off a firestorm of opposition.

This might yet happen but, given all the other Stone Age economics and thinking in Washington, you had better not hold your breath.

> "TO CUT GENUINELY VALUABLE, IF NOT DOLLAR MEASURABLE SCIENCE MISSIONS, IS A TRUE ACT OF EGREGIOUS VANDALISM

RAeS HQ, LONDON AND ONLINE
7-8 OCTOBER 2025

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